DEC 10 1935

Engineering News-Record

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Jacking a New Jersey highway pavement sidewise

IN THIS ISSUE: Moving Seven Miles of Pavement . . . Setting Railway Spans Back on Their Piers . . . Progressive Road Widening Planned for Indiana . . . Relining the Moffat Tunnel . . . Pioneer Roadbuilding in Canada . . . Soil-Loading Machine Tests Four Samples at One Time . . . Trade-Waste Treatment Plant at Belleville . . . New Spillway Permits Use of Old Earth Dam

Winter Idleness is OLD-FASHIONED

A narrow arch bridge on a road in Indiana being extended in mid-winter with Armco MULTI PLATE. The fill is placed directly against the metal plates.

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IT used to be customary, when winter approached, to stop practically all construction work. But we've since learned that "winter idleness" is far more costly than winter construction. We've learned, too, that by using "winter-proof" materials, construction costs are but little if any higher than in summer.

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FOR ECONOMICAL MULTI ARMCO PLATE WINTER CONSTRUCTION

As to Highway Safety-I

JUST now the vogue is to crusade for highway safety. Through a number of agencies the public is being made frightfully conscious of the toll taken by motor accidents. And "frightfully" is the word. For some of the crusaders are not content to rely on appeals to reason and judgment; they are enlisting the fear instinct also through recital of the most intimate and grisly details they can garner from the most ghastly accidents. They set out to make our flesh creep, and in pursuit of that morbid objective there seems to be no limit to their fertility of resource.

However we may discount that part of this crusading which is "for revenue only", designed to foster prejudice against highway transportation or to cash in on a new variety of literary thrill, the stark fact remains that many motor accidents can be avoided. Many lives needlessly sacrificed can be saved and many more victims can be spared the agony of grievous and permanent injury. But to achieve substantial progress toward this admirable objective we must do more than wallow in a gruesome flood of gory publicity.

THROUGH much of the current crusade runs an emotional motif that is directed wholly toward stimulating fear in the individual driver. The assumption appears to be that his recklessness and indifference are chiefly responsible for highway accidents. On what other basis can we explain the vogue of "frightfulness"? Of what avail thus to terrorize the great mass of drivers unless we hope thereby to frighten them into more careful driving?

Such a means of enjoining even greater caution on all drivers may be justified so far as it goes, although it is open to question whether the kind of drivers who can or will read these stories and who are susceptible to their harrowing appeal are the kind that actually are responsible for most of the serious accidents. But waiving this point and granting the value of the effort, it remains woefully unequal to the need. Of what use, for example, to frighten sensible and sensitive people off the highways while some of our states still permit any irresponsible moron who has attained the ripe age of sixteen years to pilot, without further qualification, a hundred horse-power vehicle on a public highway?

Until the states set up and enforce adequate proficiency tests for all drivers, until they establish compulsory insurance or some other guaranty of responsibility, until they deal more realistically and courageously with the parking abuse, until other and equally obvious regulation of this sort has been achieved, we still have a broad margin within which to reduce driver-hazards without terrorizing the vast majority of competent, considerate and responsible automobile owners.

But even conceding the big job that must be done on the driver, let us remember that his conduct is not the only highway hazard. The vehicle itself may be a contributing factor, although, in all fairness, we can ascribe to it but slight responsibility. Despite a few cases in which the demands of extreme styling have tucked the driver away so snugly that he needs a periscope to see the outside world and its traffic, the fact is that the motor manufacturers as a whole have embodied in their cars every device that scientific resource and engineering skill can offer to increase driving safety. Every year sees more and more progress on this score; today the modern motor car is amazingly safe for the conditions under which it must operate.

BUT those conditions—there's the rub. What of the conditions? What of the streets and highways, the tracks over which the automobile must operate? Have they kept pace with the power, speed and number of the cars? Whenever we quote statistics to show how great a percentage of motor accidents are the drivers' fault we must imply "under existing conditions." But what does that prove? Are the conditions what they can be and should be? Until we can answer yes to that question we should be showing better judgment if we were to explore that problem more thoroughly rather than to pour all of our effort into emotional crusades to frighten the motorist public into reform. Yet the present agitation devotes but scant consideration to the highway aspect of the problem.

(To be concluded in an early issue)

Willard Chevalier

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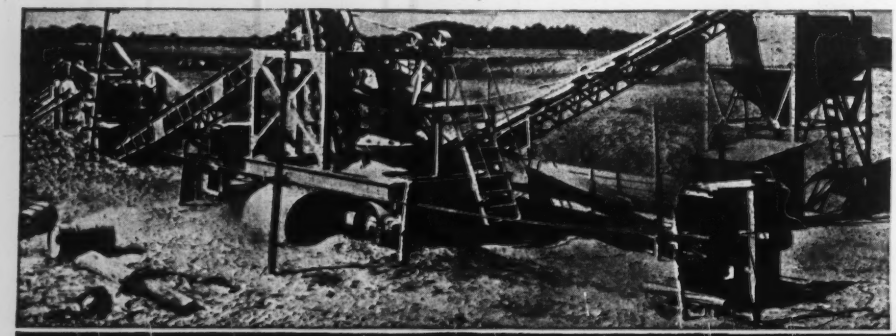

At left: Two International Harvester Diesel power units operating portable crushing plants for W. C. Burns near Driggs, Idaho. Mr. Burns, prominent road contractor of Idaho Falls, purchased these Diesel units because of their high combustion efficiency in the rarefied mountain air. The elevation at this point is 8000 feet.

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In the News:

BERMUDA, where automobiles still are taboo, is not attempting to keep airplanes from disturbing the peace of its quiet towns and countryside. Ground was broken on Nov. 18 for an air base costing $225,000. Service between New York and the islands is to be operated jointly by Imperial Airways and Pan-American Airways.

THE TECHWOOD slum-clearance project in Atlanta was dedicated by President Roosevelt on Nov. 29. The low-rent apartments for some 603 families will be ready for occupancy early in 1936. The cost will be nearly $3,000,000. The buildings occupy about 25 per cent of the 13-block area.

A CURB ON SKYSCRAPERS has been recommended to the city of New York by the Merchants Association in a report on revision of the zoning laws. Less intense use of land by requiring open spaces around the buildings and limiting their height is demanded. The recommendations are made to save real-estate operators from their own cupidity and in the interest of sensible economic development.

THE FIRST municipally owned and managed housing project in the U. S. was dedicated Dec. 3 on New York's East Side. Developed under Langdon W. Post, city housing commissioner, the remodeled tenements are to be occupied by carefully selected families who can afford to pay no more than $6.05 per room per month that is asked.

THE FIRST SCHEDULED FLIGHT of the China Clipper across the Pacific focuses attention on our constantly expanding air-transport operations, not only in foreign service but at home, where the WPA has financed new airports with a lavish hand. The Bureau of Air Commerce has just completed a set of standard hangar designs which cities may use if they wish.

THE $10,000,000 ANNEX to New York City's main post-office was dedicated Dec. 5. Containing 783,000 sq. ft. of floor space, the six floors of the building are carried above the tracks of the Pennsylvania Railroad by some of the heaviest girders ever used in building work. One of them, 116 ft. long and 110 in. deep, weighs 133 tons.

COMPLETION of the long-delayed Outer Drive at Chicago is assured through a PWA grant of $2,324,000 to the Chicago Park District for completion of the two bridges and the Randolph St. Viaduct. The PWA also has agreed conditionally to purchase $6,000,000 of the Park District bonds for park purposes.

A CONTRACT HAS BEEN LET for the second 45,000-kw. hydraulic turbine and generator for Wheeler Dam on the Tennessee. When the TVA started work on the dam, the installation of only one generator was proposed. Work on the dam is ahead of schedule.

In This Issue:

USING RUBBER HOSE as the medium through which pressure is brought to bear against the edge of long lengths of concrete pavement, the New Jersey highway department is jacking seven miles of pavement slab 12 ft. horizontally, to make way for a sodded central area separating opposing lines of traffic.

RAILWAY BRIDGE TRUSSES swept from their piers during floods in the Republican River Valley last spring were successfully set back on their piers through the use of guy derricks. The cost of dismantling thus was avoided.

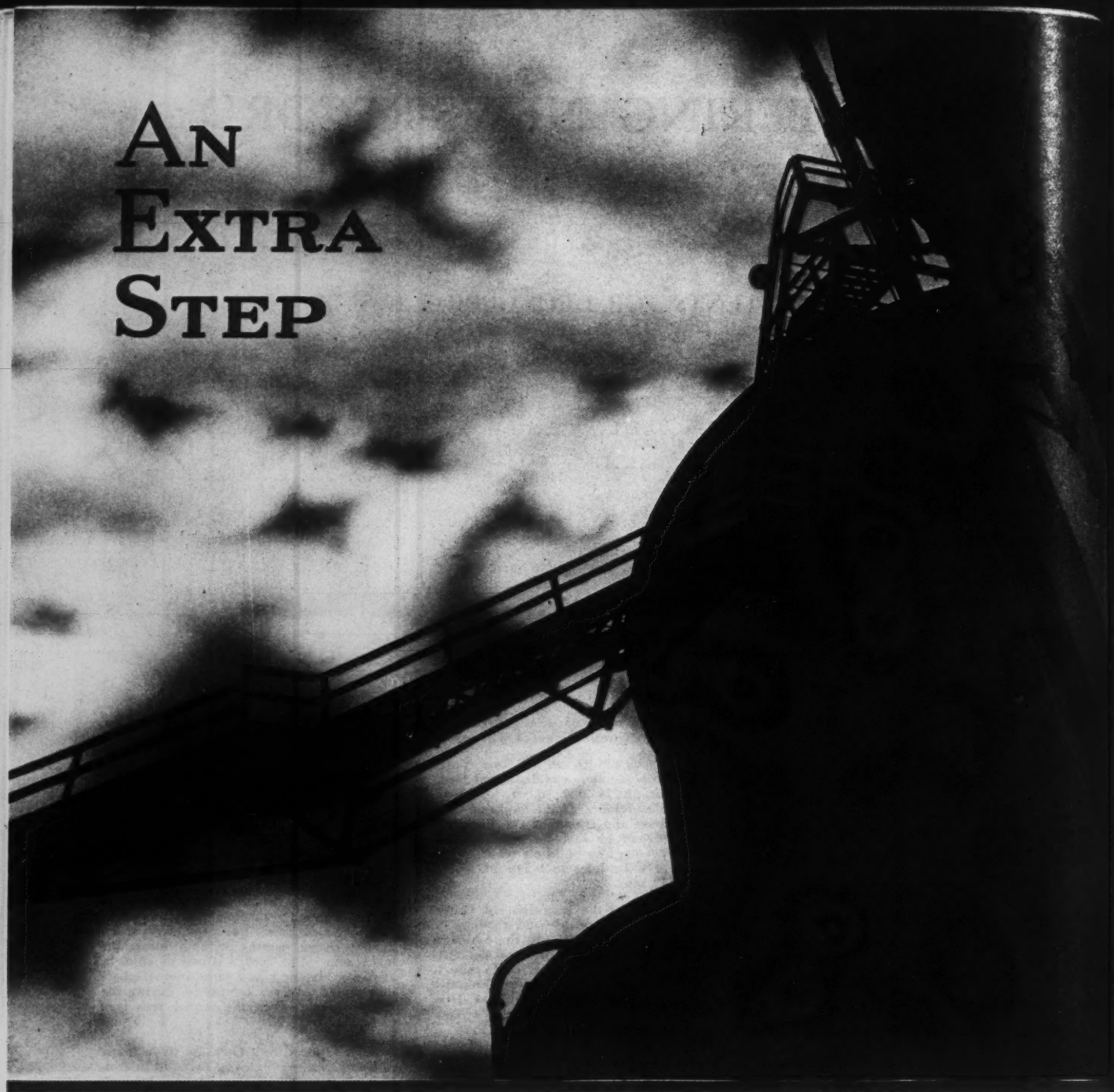
A PLAN for building more safely into old worn-out narrow pavements during reconstruction has been put forward by the Indiana Highway Commission. It calls for building new 10-ft. strips of pavements along the outer edges, leaving the old pavement for passing only. Ultimately two more outer strips can be added, the old pavement being torn up and the area planted to create a divided-lane pavement.

RELINING of the timbered sections of Moffat Tunnel, replacing the timber with reinforced concrete, has been carried on during recent months without interrupting traffic. The record is one of efficient advance planning and intensive construction under adverse conditions during the short periods when the tunnel was free of traffic.

BOTH QUEBEC AND ONTARIO have many miles of pioneer highway to build to connect their outlying mining and agricultural areas in the north with the settled sections of the provinces. Some of the work has been carried out as a relief measure, part of it on the uncompleted sections of the long-projected Trans-Canada Highway.

TESTING SAMPLES OF SOIL in the comparatively new research field of soil mechanics has been difficult for lack of testing machines that met the exacting requirements of such study. Apparatus recently developed at Harvard goes a long way toward filling this need.

THE CONTINENTAL DAM on Clear Creek, Colorado, an earthfill structure, has been made available for use to its full capacity by the construction of a new spillway. For six years water has been kept low in the reservoir because of inadequate spillway capacity made overtopping possible.



If you took only a casual look at the powdery gray material in these tanks, you might think it was cement. But you couldn't make concrete with it. It's "raw-mix"—the ground raw material from which cement is made.

Many more steps must be taken—testing, blending, burning, more grinding—before Atlas and Universal portland cements are produced.

And after that we take another step, not in the specifications. That is the step of working with you in the *use* of these cements.

We are not construction experts and don't pretend to be. We are cement makers, who have had opportunity over a number of years to gather considerable material on cement performance. Sometimes we can find in that material certain information that is helpful on a particular concrete job.

Any time you have a concrete problem on which we can help in this way, we'd like to hear from you. No charge, of course, because this extra step is a regular step in the making of every barrel of Universal and Atlas cements that go to make good concrete. Try us out!

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December 5, 1935

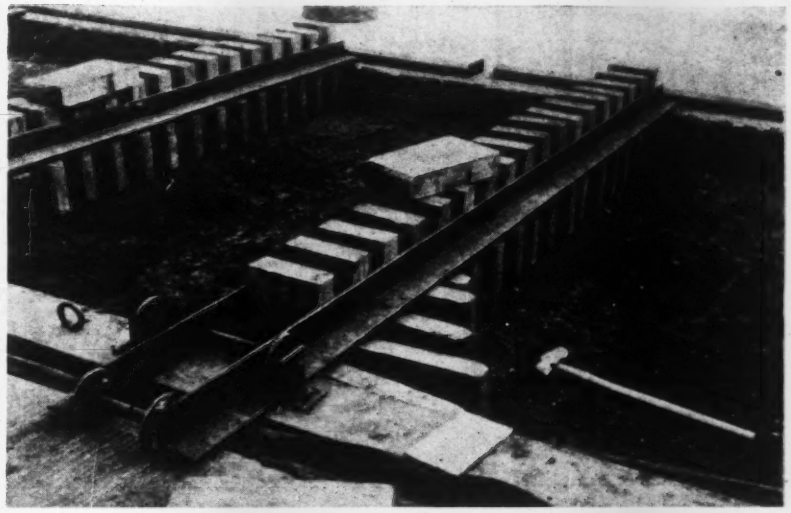


FIG. 1—FINAL SHOVE COMPLETED and moving equipment ready to be shifted for another 12-ft. move of a 500-ft. length of 14½-ft. slab.

Moving Seven Miles of Pavement Twelve Feet Sidewise

Concrete slab 14½ ft. wide separated from bordering slab in 500-ft. section and pushed sidewise by air pressure to form part of the second half of a dual highway in New Jersey

By S. Johannesson
Engineer of Design, State Highway Department, Trenton, N. J.

A CONCRETE pavement slab 14½ ft. wide is being shoved 12 ft. to one side and rebedded to form a part of the widened Brunswick Pike (N.J. 26, US1) south of New Brunswick, N. J. Seven miles of slab is being moved. The slab to be moved is cut across at intervals of 400 to 500 ft.; the longitudinal joint between it and the adjacent slab are ploughed out, removing the bituminous filler; a flattened hose is inserted in the open joint and inflated by compressed air, moving the slab; a larger hose is inserted in the widened joint and inflated, again sliding the slab; this process is repeated, alternately inflating and deflating the hose and inserting blocking behind it, until the slab has been moved the full 12 ft. After it is moved the slab is raised to profile and bedded by mud jacks and a paving gang follows constructing a 10-ft. slab along the outside edge of the moved slab. These operations are now in progress at the rate of 600 ft. of slab moved each eight-hour day.

FIG. 2—CONTROL VALVE that admits compressed air to hose that moves 14½-ft. slab in 500-ft. lengths.

The present road is a heavily-traveled trunk highway paved 39½ ft. wide and marked for four travel lanes (Fig. 4). The pavement is in three strips, two of which are each 14½ ft. wide and the third 10½ ft. wide; the work being done is to rearrange the paved way so as to provide two roadways each about 25 ft. wide separated by a center island 12 ft. wide. The two easterly strips (Fig. 4) will remain as they are to carry northbound traffic, and a new roadway is being provided for southbound traffic. This will consist of the present westerly 14½-ft. slab moved west 12 ft. and a new 10-ft. slab. The old and new arrangement is indicated clearly by Fig. 4.

The old pavement structure was ordinary; the 14½-ft. strip to be moved was 9 in. thick and had transverse joints about every 34½ ft. These joints were doweled and filled with premolded mastic joint filler. The longitudinal joint is a simple undoweled joint with vertical sides and premolded mastic filler. The subgrade is a gravel-sand loam, and the

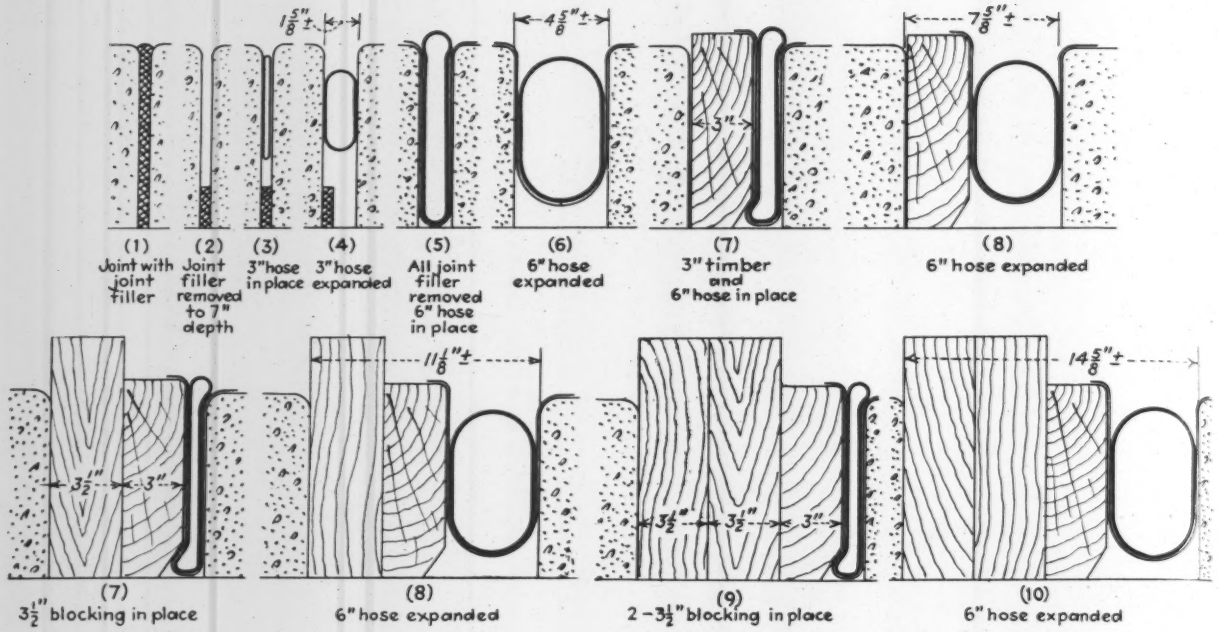

(1) Joint with joint filler
(2) Joint filler removed to 7" depth
(3) 3" hose in place
(4) 3" hose expanded
(5) All joint filler removed 6" hose in place
(6) 6" hose expanded
(7) 3" timber and 6" hose in place
(8) 6" hose expanded
(7) 3½" blocking in place
(8) 6" hose expanded
(9) 2 – 3½" blocking in place
(10) 6" hose expanded

FIG. 3—SEQUENCE OF OPERATIONS in opening up and widening joint for insertion of head blocks ready for routine of repetitive moving operations.

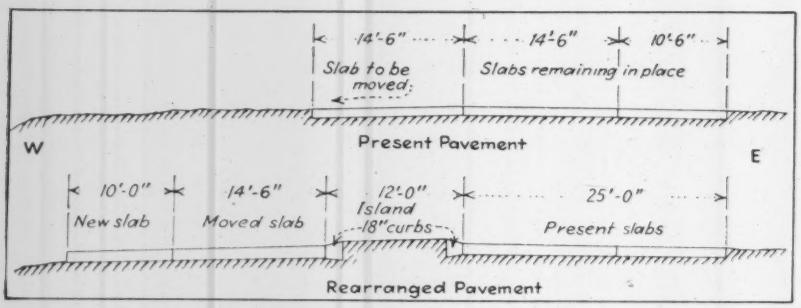


FIG. 4—SECTIONS OF OLD ROAD and of road as it will be when present reconstruction is completed.

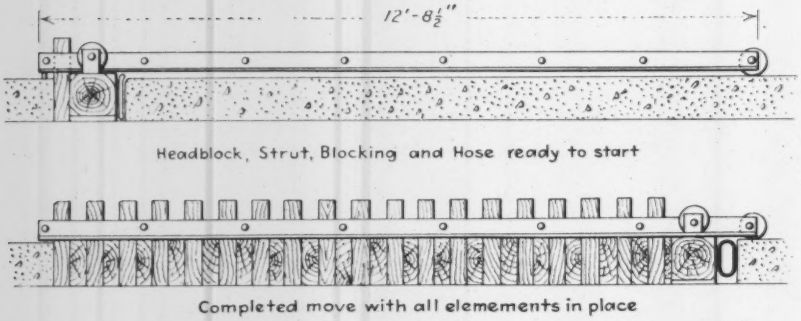


FIG. 5—SCHEMATIC SKETCH of slab-moving elements at beginning and end of a move.

slab is of uniform thickness. A section of the pavement 500 ft. long weigh about 400 tons.

Moving process

The general process of slab moving is shown schematically by Figs. 1, 3 and 5. The procedure illustrated is as follows:

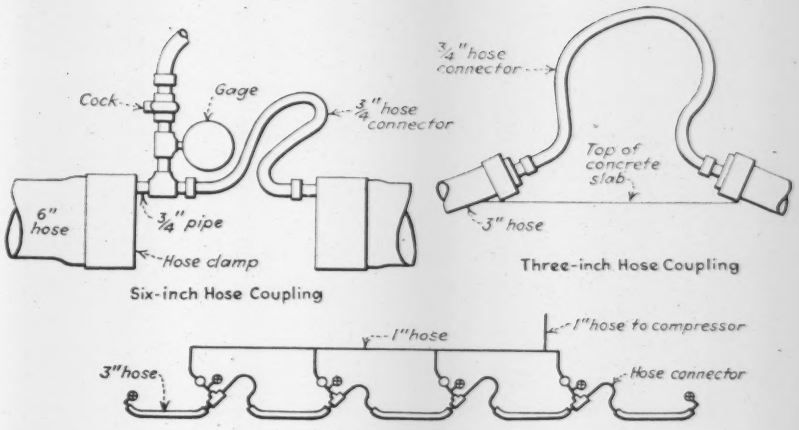
At the ends of a section the slab is cut free at a transverse joint by removing about 3 in. of the concrete and cutting the dowels. At the same time the joint filler is removed from the longitudinal joint to a depth of about 7 in. by a plough, devised for the purpose and having a blade ⅜ in. wide. This blade is inserted in the joint, and two cuts are made, the first to a depth of 4 in. and the second to the full depth. The plough is pulled by a 10-ton roller at a speed of from 3 to 4 miles per hour: the filler comes out of the joint in strips. After the ploughing is completed, small parts of the filler that may remain in the joint are cleaned out by hand.

A 3-in.-diameter line fire hose is then inserted in the joint. The hose is of the ordinary type found on hose reels for fire protection in office buildings and stores; when flat it measures about 1 in. in width. It is therefore narrow enough to be inserted for its full depth in the opening ploughed out in the longitudinal joint. The hose is not airtight when dry, but when thoroughly soaked in water inside and outside it becomes sufficiently airtight for the pavement-moving operation.

After the hose is in the joint, air under pressure is introduced, expanding the hose and causing the slabs to be moved to travel laterally until the joint opening is about 1¾ in. wide. The reason why the slab moves under the air pressure rather than the remainder of the pavement is that this part of the pavement is wider and therefore heavier than the slab, and in addition is supported against lateral movement by a wide gravel and earth shoulder.

After the 3-in. hose is properly expanded, it is deflated and removed from the joint opening. A 6-in. rubber-lined cotton-jacketed hose is then inserted in the opening and expanded under air pressure until the width of the opening is increased to about 5 in. The hose is then deflated and a plank, 3 in. wide, is inserted behind the hose, and the hose is

FIG. 6—HOSE and connections as arranged for moving a 500-ft. length of 14½-ft. slab.



again inflated, increasing the width to about 8 in. After deflation, blocking 3½ in. wide is inserted behind the plank, the hose is inflated and subsequently deflated. This process is repeated once more, and the width of the opening is then about 15 in. The plank and blocking is then removed, and in their place is inserted 10x10-in. timbers which are used throughout the remainder of the move as direct backing for the hose, small blocks being inserted one after another behind the timber as it moves ahead.

The remainder of the process of moving consists of inflating the hose, deflating it and placing additional blocking behind the timber until the moving is completed. Fig. 3 shows diagramatically the various steps of the procedure up to the insertion of the 10-in. timbers.

FIG. 7—DRILLING HOLES in moved slab through which grout is pumped underneath slab to raise it to planned profile.

The blocking used is timber 3½ in. thick, 10 in. wide and 18 in. long. Four sets of blocking are used for each 34⅓-ft. slab length. To hold the blocking in place, there is provided for each set of blocking two 4x4x⅜-in. steel angles, held together by ¾-in.-diameter bolts. The blocking pieces are set alternately between the angles and laid below the angles so as to make the blocking secure.

Detail operations

While it was simple in general plan, the process outlined required exceptional study of details both of equipment and of procedure. Estimates of the slab weight of about 0.8 ton per foot and of the shear resistance of the subgrade soil (the slab does not slide on the soil but on a shear plane between a thin layer of soil carried with the slab and a stationary soil bed below) indicated that, with a hose bearing surface 2½ in. wide, an air pressure of 75 lb. would move the slab. In actual operation the pressure at the compressor plant is about 100 lb., and it decreases to about 80 lb. at the ends of the slab-moving hose line.

The compressor plant consists of two portable compressors, each with a truck-mounted air receiver; these units are tractor-hauled in train along the road shoulder and are set up for each move

FIG. 8—MUD-JACK OUTFIT raising slab by pumping cement-loam grout through drilled holes.

FIG. 9—MOVED SLAB, showing accuracy of line and level obtained.

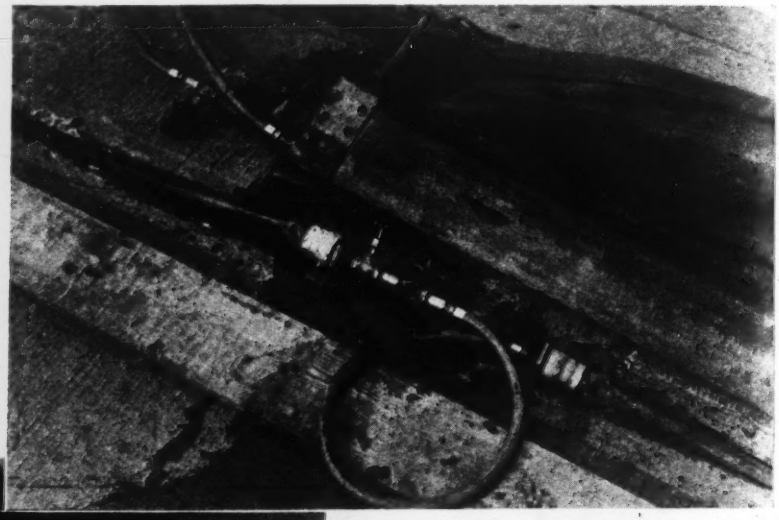


FIG. 10—OPERATIONS IN APPLYING SLAB-MOVING HOSE. (a): Ploughing out longitudinal joint filler. (b): Rolling 3-in. hose flat for insertion in ploughed joint. (c): Hose inserted in joint by hand. (d): Connection of 3-in. hose lengths after insertion in joint. (e): Special flat connection to permit insertion of 6-in. hose into joint.

at about midlength of the slab being moved. The compressors have each a capacity of 210 cu.ft. of free air per minute at 110 lb., and the receivers have a capacity of 144 cu.ft. Air lines from the receivers lead to a simple control table, where a single valve (Fig. 2) admits pressure to the air lines leading to the slab-moving hose, as shown by the sketches of Fig. 6. About 500 cu.ft. of air are used for each shove with the 6-in. hose.

As shown by Fig. 6, 100-ft. hose lengths were used for the 3-in. hose and coupled together to make the 500-ft. line for slab moving. The 6-in. hose was coupled in 30-ft. lengths. To fit the couplings to the narrow space

which the deflated hose must occupy offered a nice problem, particularly with the 6-in. hose used for all but the preliminary shoves of the slab. With the small hose no special coupling was attempted, the ends being allowed to rise out of the joint as shown by Fig. 6 and also by Fig. 10d. For the 6-in. hose a special coupling was designed as shown by Fig. 10e, which would enter the joint space available.

In some respects the first movement of the slab is the critical operation. The longitudinal joint is only ½ in. wide, and in this space there is no room to spare for a 3-in. hose flattened to the thinnest possible ribbon. The removal of the joint filler by plough and by hand is very thorough, and the hose is carefully prepared. After being covered with graphite, the hose is ironed flat on a clean surface, all adhering dirt is swept off, and it is pressed into the joint carefully by hand. These operations are indicated by Fig. 10a, b and c. When once the slab has moved its first 1¾ in., the succeeding procedure is more simple, and when the 6-in. hose is in place the operations of inflation, slab movement, deflation, blocking behind and repeating the sequence proceed with almost clocklike regularity. As stated, there are four blocking struts to a 34½-ft. slab, and three men to each slab operate the deflation vent, pry ahead the head block with bars, and insert the follower blocks for all four struts one after the other. The head block is a longitudinal timber 9⅝ in. square, with one chamfered corner and is 15 ft. 2 in. long. This timber has two steel eyebolts for handling and two roller guides which support the timber on the steel blocking struts as shown by several of the illustrations. There are two head blocks to each 34½-ft. slab. The follower blocks are 18x9⅝ in. and 3½ in. thick with the long edges battered ¼ in.

The movement of the slab is smooth and without jar in almost perfect alignment, as shown by Fig. 9. No slab cracks have resulted, and the only evidence of the moving operation is a slight crack in the surface of the asphalt filler along some of the transverse joints.

Bedding moved slab

In its original position the moved slab has a straight dip of 2½ in. toward the outer edge, while in its new position it will have a slope of 1¾ in. In preparing the subgrade for the new placement it is finished to the same slope because it is desired to have the slab below rather than above its final position. This makes it possible to raise the slab in its new position to the cross-profile of its side of the ultimate dual pavement and to provide at the same time a bed for the slab. Ordinarily the lift is about 1 in. at the outer edge, decreasing to a fraction of an inch at the inner edge.

The slabs are bedded and adjusted to proper grade by grouting through holes previously drilled through the concrete. The grout used consists of 1 part of cement and 6 parts of top soil and is applied by an ordinary mud-jacking machine.

Immediately after the slab has been moved over and properly bedded, it is intended to construct the center island with its curbs and also the additional 10-ft. strip of pavement so as to place the new roadway in operation without delay.

The present work will cover a length of about 7 miles of highway and is being done by force account by the New Jersey State Highway Department. After it has been done it is expected that the work for the remaining 33 miles of highway will be carried out under contract.

The present work is under the maintenance division of the New Jersey State Highway Department, E. Donald Sterner being the state highway commissioner. W. G. Sloan is state highway engineer under whose direction work is carried out. A. W. Muir is superintendent of maintenance. The methods of moving the slabs as above described have been developed by the writer, who is engineer in charge of the pavement-moving work.

Fire Walls Prove Ineffective in Saving Long Trestle

By Searcy B. Slack
Consulting Engineer, Decatur, Ga.

IN the early morning of Oct. 5, fire of undetermined origin destroyed the 1,645-ft. south approach trestle to the highway bridge over the Ocmulgee River at Lumber City, Ga. This was the first fire of any magnitude on any of the highway bridges in Georgia since the organization of the state highway department in 1919.

The trestle, built in 1925, consisted of 87 spans of 18 to 19 ft., built of creosoted pine timber and carried on four-pile timber bents 14 to 19 ft. high, with sash bracing in each bent and tower bracing between alternate bents. A 4-in. creosoted plank floor covered with a 2-in. wearing surface of asphalt and slag was used.

A significant fact about the fire is that fire-breaks provided in the trestle at intervals of about 200 ft. proved entirely ineffective. The fire-breaks used consisted of timber bulkheads made up of 3-in. planks and extending 3 ft. outside the sides of the bridges, 5 ft. below the cap and up between the stringers. The maintenance crew reported that a light breeze from the north carried the fire rapidly along the trestle, and that the fire was so intensely hot that flames leaped from one to two spans at a time. A dense black smoke several hundred feet ahead of the flame prevented effective work in cutting the trestle. The fire apparently started on the deck of the bridge near the northern end, and the small amount of undergrowth under and around the bridge indicated that the bridge burned it and that the fire was not spread by it along the bridge.

The trestle was completely destroyed in 2½ to 3 hours. The intense heat caused considerable scaling and spalling on the face of the reinforced-concrete abutment at the south end and some spalling and several cracks in the concrete pier at the north end where the trestle connected with the steel spans over the river. Aside from some blistered paint, the steel-truss spans were not damaged.

REMAINS of a 1,645-ft. trestle after a fire.

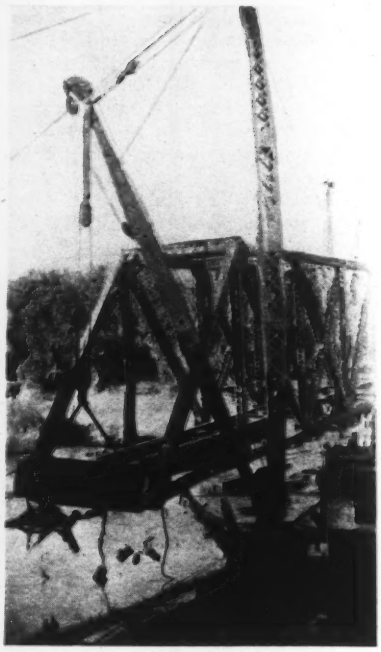
Guy Derricks Lift Railway Spans Back Onto Piers After Flood

By Paul Emery
Office Engineer, Kansas City Bridge Co., Kansas City, Mo.

THE FLOOD last June in the Republican River Valley in western Nebraska and northern Kansas washed out the three 107-ft. steel truss spans of the Chicago, Burlington & Quincy Railway bridge near Republican City, Neb., on the branch line south to Oberlin, Kan. Returning these spans to their foundations by guy derricks that lifted each of them as a unit constituted an unusual operation.

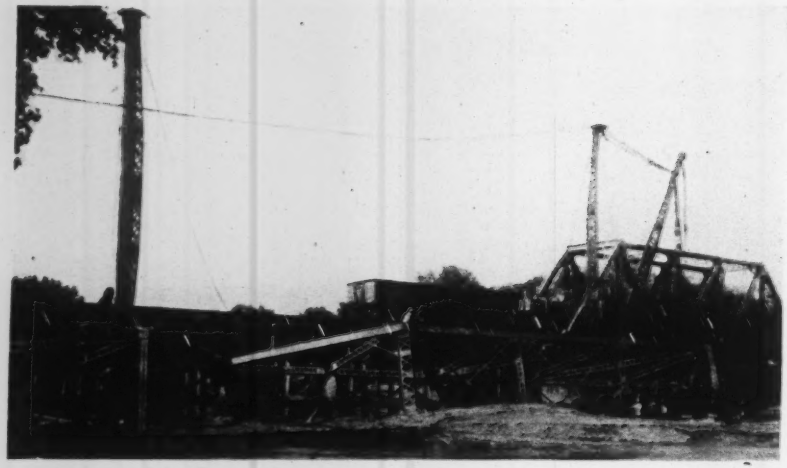
One of the accompanying views shows the wrecked spans. The current hit the bridge at an angle so that the spans were carried endwise about 8 ft. as they went off the piers and rolled over on their sides. One span was carried about 35 ft. downstream, the other two not so far. The spans were covered with drift and, as the floodwaters receded, considerable sand was deposited around them.

Since this branch line was needed for the movement of wheat, the railroad company immediately built a temporary wood trestle. This trestle was first built at the proper elevation for its use as falsework for the steel and then later raised about 4 ft. by pony bents, to care for a raise in grade. Examination of the exposed portions of the steel spans did not show serious damage, so a contract was let to the Kansas City Bridge Co. to place the spans back on the piers. The method adopted was to lift each span as a unit by means of two 40-ton guy derricks. Each span weighed about 80 tons.



AN 80-TON TRUSS of 107-ft. span suspended from two guy derricks which are lifting it back onto its piers.

THE WRECKED SPANS as they appeared after the Republican River floodwaters had receded.



TEMPORARY TRESTLE permitting train movements during the rebuilding served also as falsework in re-erecting the steel spans.

The guy derricks had 60-ft. masts and 50-ft. booms. They were erected on pile platforms driven near the downstream noses of the piers, one at each end of the particular span to be lifted. By running rather long guys to trees, it was possible to avoid the use of deadmen. Each derrick had its own hoisting engine, one set on each bank and remaining in that position for all three lifts.

A locomotive crane, running on the trestle, was used to remove the old track and driftwood from the wrecked spans, and also to drive the pile platforms and erect the guy derricks. After the drift had been cleared off, a span was rolled over into its upright position and hitches placed on the floor beams near the shoes. A water jet was used to free the span from the sand.

The time for making a change-out averaged about three hours for a span. After the passing of a train, the locomotive crane was used to remove the track, the stringers and pony bents from the trestle. The span was then raised by the two guy derricks, swung around and landed on the piers and blocked up on the falsework. The track was then replaced by the crane in time for the next train.

The spans were but slightly damaged. The lower chord in the last panel on the upstream side of each span was bent up, evidently as a result of this member sliding over the pier as the spans tipped. Several diagonals and verticals were also slightly bent. These members were all repaired and replaced while the spans were on the falsework. The method resulted in a minimum de-

lay to trains, and the entire operation was completed within a month's time.

The work was done by the Kansas City Bridge Co., Kansas City, Mo. O. A. Zimmerman is chief engineer, working under F. T. Darrow, assistant chief engineer and G. A. Haggander, bridge engineer, for the C. B. & Q.

Progressive Road Widening Planned for Indiana

By John W. Wheeler
Member, Indiana Highway Commission, Indianapolis, Ind.

AT THIS TIME when a great campaign for safety on the public roads is in progress it is well worthwhile to consider what is to be done with some of our existing state highways. A few of them have actually been worn out because traffic has developed on them far in excess of what was calculated by their designers, and others have merely settled and cracked until they are rough, uncomfortable to drive on, costly to maintain and in some instances dangerous.

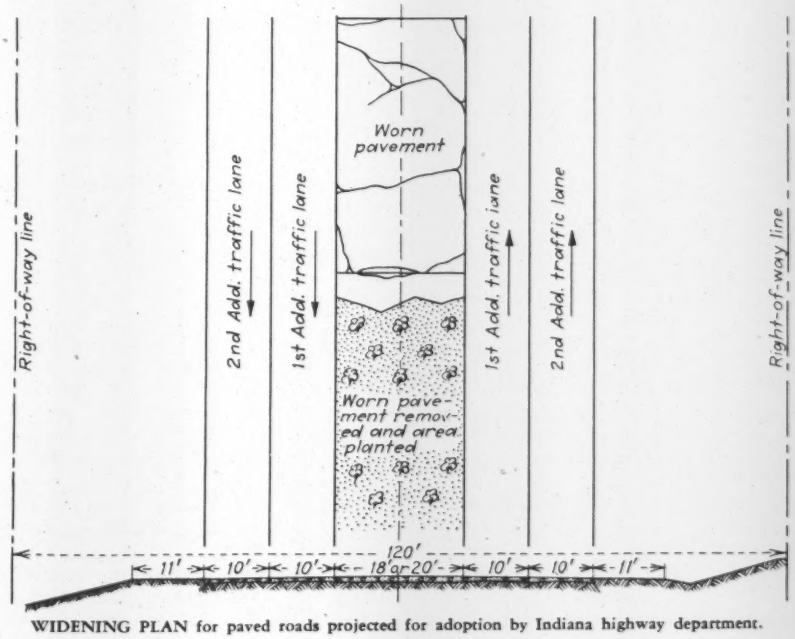
What will we do with that old worn pavement which structurally has a great deal of strength left, but which is now worn to the extent that its betterment should be considered? The first natural suggestion that might be offered would be to resurface this worn and rough road with one of many suitable resurfacing materials. To this method there are several objections. The road has probably proved itself to be too narrow for modern traffic, and its grade and alignment may be very dangerous, considering our present-day traffic speeds. Few roads in my opinion, if they are on the main trunk-lines, are suitable for resurfacing in their present narrow pavement widths.

After much discussion on this subject, members of the state highway commission of Indiana have brought forth the following solution and claim practicability for it in many cases. If the grade and alignment are not too bad, and if some additional right-of-way can be procured, we feel that the accompanying design has much merit. Along present old and worn pavement we would lay a 10-ft. lane on each side. This would give the traveling public new 10-ft. traveling lanes on the outside of the worn pavements, and it would merely use the old pavement as a passing lane in this improved 40-ft. pavement. Because the outside lane, or right side, presented a much better driving surface than the old pavement, traffic would automatically line up in the outer lane and leave that lane only when it was necessary to pass another car going in the same direction. The two center lanes, consisting of the old pavement and the part where collisions would be most likely to occur from cars meeting while traveling in opposite directions, will be practically free from traffic. We will thus get several years more wear out of the worn pavement, and give the traveling public the two new lanes.

As revenues accrue and more money is available for this particular highway, we will lay a second additional 10-ft. lane on each side and at this particular time tear out the original pavement, leaving in its place a sodded center strip, 18 or 20 ft. wide, depending on the width of the original pavement. We now have two 10-ft. traffic lanes on each side of a 20-ft. parkway, which should prevent all accidents caused by cars from opposite directions meeting, and we have obtained the maximum value from the old pavement and delivered to the traveling public what is now considered to be the safest type of pavement, commonly called the divided-lane pavement.

We are faced with one serious difficulty in carrying this plan out. Originally state highway rights-of-way were acquired in 50- and 60-ft. widths. Later as the widened shoulder became an apparent safeguard to travel, we obtained 80- and 100-ft. widths, but this new plan of divided-lane highways will necessitate 120 ft. of right-of-way, and in country where the topography is very rough, even greater widths. This plan will necessitate the acquiring of additional right-of-way and the moving of a great many buildings, but when the toll of human life that is now being paid is balanced against the additional cost of right-of-way and property damage, for the sake of humanity, the expense must be met and the bill paid.

Until the design of motor vehicles and highways are coordinated, or until speeds are reduced from their present mark, the highway engineer must adopt some plan of his own that will curtail the appalling motor-accident death rate. The state highway commission of Indiana and its engineers offer this as a feasible plan for better and safer highways.



WIDENING PLAN for paved roads projected for adoption by Indiana highway department.

Long-Span Cantilever Bridge Planned at Calcutta

Bids from two British concerns, from one German and one Indian, for what will be one of the world's largest-span cantilever bridges, are now under consideration by the Howrah (India) Bridge Commissioners. With a main span of 1,500 ft. as compared with the 1,700-ft. spans of the Forth Bridge and the 1,800-ft. span of the Quebec Bridge, the new bridge over the Hooghly River will cost about $8,750,000 and will require the use of 17,000 tons of high-tensile steel and 9,000 tons of mild steel.

The Howrah Bridge will carry very heavy road traffic, a double set of streetcar tracks down the center and 15-ft. sidewalks on each side. The roadway will be 71 ft. wide. The main towers will rise to a height of 300 ft. above the ground, dominating Calcutta, Howrah and the surrounding countryside.

Ingenious Relining Procedure in a Traffic-Burdened Tunnel

Distorted and deteriorating timber lining of the Moffat Tunnel is replaced with concrete between frequent train movements and in a cold and gas-fouled air

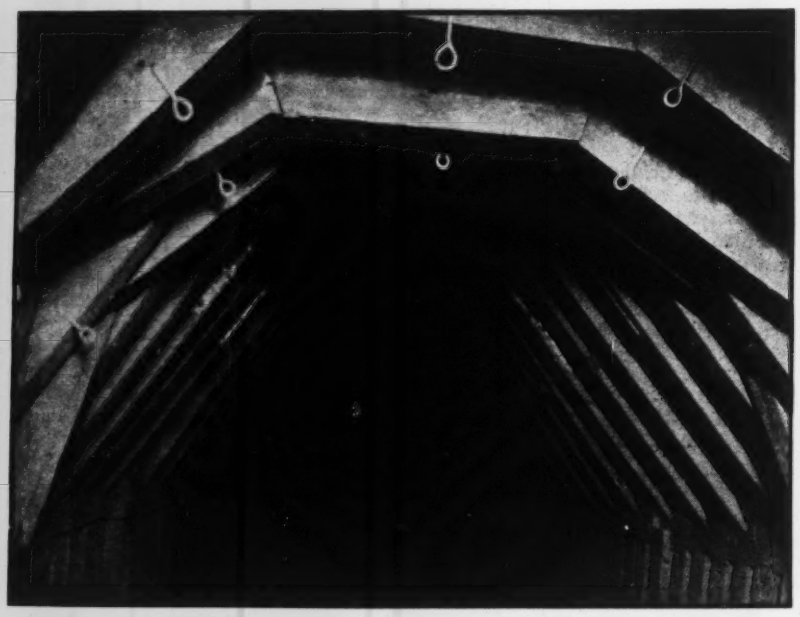


FIG. 1—VARIATIONS in timbering of Moffat railroad tunnel; thousands of feet of timber like this are being replaced with concrete lining, the work being done without interruption to traffic.

ALL of the timber lining originally installed in more than half the length of the famous 6.21-mile Moffat railroad tunnel that pierces the Continental Divide 50 miles west of Denver is being covered or replaced with reinforced concrete by railroad construction forces under most trying working conditions. In sections of very bad ground, where the original timbers were placed skintight and often in double rows, the work is being removed entirely and replaced with concrete reinforced with arched steel-rail sets. In better ground, timbers with a minimum of 3-ft. spacing are left in place, and are trimmed where required to allow at least 6 in. of concrete to be placed over the inside faces of the timber. As all untimbered sections have been coated with gunite, the tunnel will be protected throughout with concrete when the present reinforced-concrete lining is completed.

Under the terms of its 50-year lease (with option for a 49-year extension) from the Moffat Tunnel Improvement District, the Denver & Salt Lake Railway (Moffat Road) is required to maintain the tunnel. Since Feb. 26, 1928, when the railroad commenced operation through the tunnel, maintenance of the timbered section has been troublesome and expensive, some of the timber replacement costing as much as $300 per lin.-ft. of tunnel. Atmospheric conditions within the tunnel caused rapid rotting of the timber, which necessitated frequent and expensive renewal.

Ventilation of the tunnel for steam-engine operation is by fan equipment, located at the east portal and consisting of one 550-hp. and one 750-hp. electric-drive unit and a 600-hp. diesel stand-by unit. When a train enters the tunnel from either end, an electrically operated airtight vertical drop of five-ply canvas curtains with steel guides closes off the east portal and the high-capacity fans go into action. For westbound trains the fans draw the smoke out through the east portal, discharging through louvres at the top of the ventilating plant, and for eastbound trains the smoke is blown out of the west portal; in both movements the smoke is forced back over the train. Much of the tunnel is wet, and between trains the timbers become soaked, only to be dried out by the high-velocity ventilating draft carrying hot gases. Frequent wetting and drying of the wood causes fungi growth, resulting in decreased timber life.

For five years the railroad carried on a regular timber-replacement program, sometimes costing more than $75,000 per year. This was a losing and expensive fight, and in 1933 the chief engineer of the railroad completed plans and cost estimates for relining the timbered sections. It was estimated that the entire 16,515 ft. of timber could be covered, or replaced entirely where necessary, with concrete at a cost of $887,000, figuring 4.24 cu.yd. of concrete per foot of tunnel at a cost of $12.67 per cu.yd., including reinforcing. The work was started by railroad construction forces in June, 1933, and has continued to date except for a ten-month shutdown from Sept. 30, 1933, to July 21, 1934. The cost will exceed the original estimate, due to increased traffic occasioned by diversion of D&RGW Railroad trains over the Dotsero Cutoff, which began June 15, 1934. The actual lining required to date has been 3.82 cu.yd. per lin.-ft. instead of the estimated 4.24 cu.yd. Work will be completed late this year.

Original conditions

The tunnel, 32,798 ft. long, slopes upward from both portals to an apex 18,753 ft. from the west end. About two miles in from the west portal is the now-famous Ranch Creek fault, a squeezing-ground section 920 ft. long that required structural-steel supports and immediate concrete lining when the tunnel was driven. In other locations a total of 834 ft. of concrete lining had been placed when the railroad started its present lining program. East of the apex only 1,047 ft. of tunnel originally required timbering. West of the apex 4,254 ft. of timber was required between the summit and the fault, and the entire 11,234 ft. west of the fault was timbered. The timbered sections were thus roughly divided into three groups: (1) east of the apex, (2) west of the apex and east of the original Ranch Creek fault concrete lining, and (3) west of the latter concrete.

As records of the original timber installations were not available, the engineering staff of the Moffat Railroad had to make a careful survey of the tunnel preliminary to plans for the relining. In this survey the tunnel was divided into 40-ft. sections, and a detailed report, accompanied by numerous drawings, was made on the existing condition of each section. The survey revealed curious and interesting situations in respect to clearance and alignment.

The tunnel was supposed to have been driven on a straight alignment from portal to portal and to clearances of

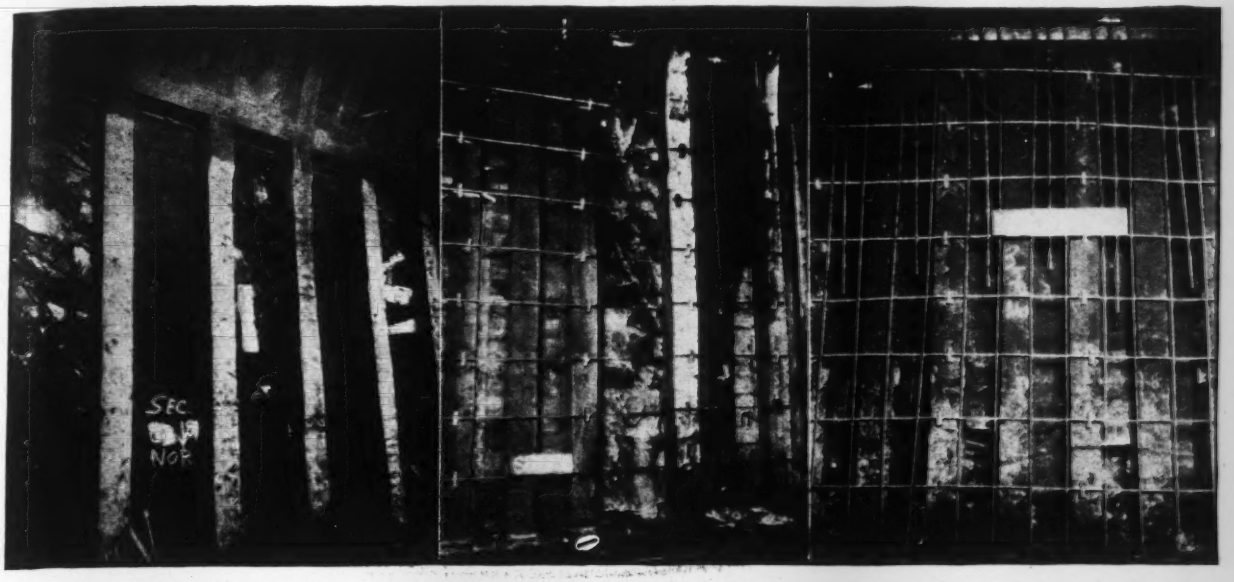


FIG. 2—TIMBER LINING is being treated in various ways preparatory to placing a permanent concrete lining. Left: alternate bays of lagging removed and posts trimmed for concrete clearance. Center: occasional bay of lagging is removed and an out-of-line post is trimmed. Right: the original lining undisturbed except for cutting out a few pieces of lagging to allow the concrete to bond with the rock.

16x24 ft. in rock and 17x25 ft. in timbered sections. Actually, as revealed by the survey, the clearance width in the timbered section varied from 15½ to 21½ ft., and the height above rail from 21 ft. 2 in. to 25½ ft. The alignment was found to depart repeatedly from a straight line. To meet this last condition, the railroad, in establishing the most economical center line, finally adopted one with thirteen changes in alignment.

Many variations in timbering were found. Some of the arch sets were of five segments, others were of three segments, and often the two types were found mixed indiscriminately (Fig. 1). Posts were found to lean both in and out from plumb position. Various types of wall plates were also found, some of dimension timber, others of steel I-beams with the web flat or inclined; in other sections wall plates were not used, the posts being framed directly into the arch sets. In some sections wood lagging had been installed, either open or tight, in part or all of the perimeter. Foot blocks were found under some of the plumb posts, but not in all cases. Side-drains had been built in part of the tunnel, but not for the full length. The exact position of every piece of timber was plotted upon the survey report drawings. Fig. 5 is typical of the information recorded and plotted for each 40-ft. section.

The widely varying conditions in timbering, clearances and alignment are accounted for in some cases by difficulties encountered in driving the tunnel, but in other cases, especially in fairly sound rock, they are not easy to explain.

In designing the new concrete lining the first requirement was that it must support the ground under existing pressures, and the second was that the lining should provide uniform inside clearances of 16-ft. width and 14-ft. straight wall height above the top of the rail to the springline, with a semi-circular arch of 8-ft. radius, giving a maximum height of 22 ft. from the top of the rail to the underside of the arch at the center line.

The varying conditions along the tunnel precluded the adoption of a single general plan for the entire length of lining. Therefore, the design was to provide a series of linings to resist the varying ground pressures and conditions as encountered in different parts of the tunnel.

The basic assumption accepted the original timbering as indicative of the pressures existing at any point, which appeared reasonable since the timbers had been in place and under observation for seven years. If timbers of a certain size and spacing had successfully held a section of ground, it was considered that a concrete lining designed for a working stress equal to the ultimate strength of the timber would be adequate. As practically none of the timber was stressed to its ultimate strength, this basis of design provided a factor of safety in addition to that of the concrete above its assumed working stress. Many timber sets, improperly blocked and out of equilibrium, even when orginally installed, naturally provided far less support than that provided by the concrete design.

In designing the lining much study was given to the many theories advanced and to the observations made of ground pressures in tunnels, shafts and mines during the past 30 years. Observation made in the Moffat Tunnel indicated that in general the ground had attained a reasonable state of equilibrium, or arching action, through the presence of the timber support. This theory was substantiated in several cases where it was necessary to remove complete sections of timber preparatory to concreting.

Examples of preliminary computations of problems to be encountered and basic computations of design of lining are indicated in Fig. 3. An attempt was made to design a lining such that the line of resultant thrust would fall within the middle third. Equilibrium polygons were calculated and plotted for varying load conditions as far as was possible.

The lining was designed for a minimum thickness of 6 in. of concrete in front of timbers left in place at the sides and 12 in. at the crown. No timber sets were to be left in place closer than 18 in. between timbers. The minimum reinforcing was to be 27 longitudinal bars, and radial reinforcing was to be used where necessary.

After the concrete cross-section had been designed, the next step in planning was a careful analysis to determine the best and most economical treatment of the timber lining for each 40-ft. section. For most of the bad-ground sections, where the timber was extremely heavy, and usually out of line or otherwise in bad shape, the plans called for removal of wall wood and its replacement with heavily reinforced concrete.

Where the timber was to come out, some means had to be provided for holding the ground until the concrete could be placed. Two plans of ground support were considered: (1) steel H-beam sets; and (2) side and arch sets of standard T-rail. The second plan was adopted, 80-lb. rail being used. The suitability of the rail sets both for holding the ground and for concrete reinforcement fitted well into the design requirements; as reinforcing, the con-

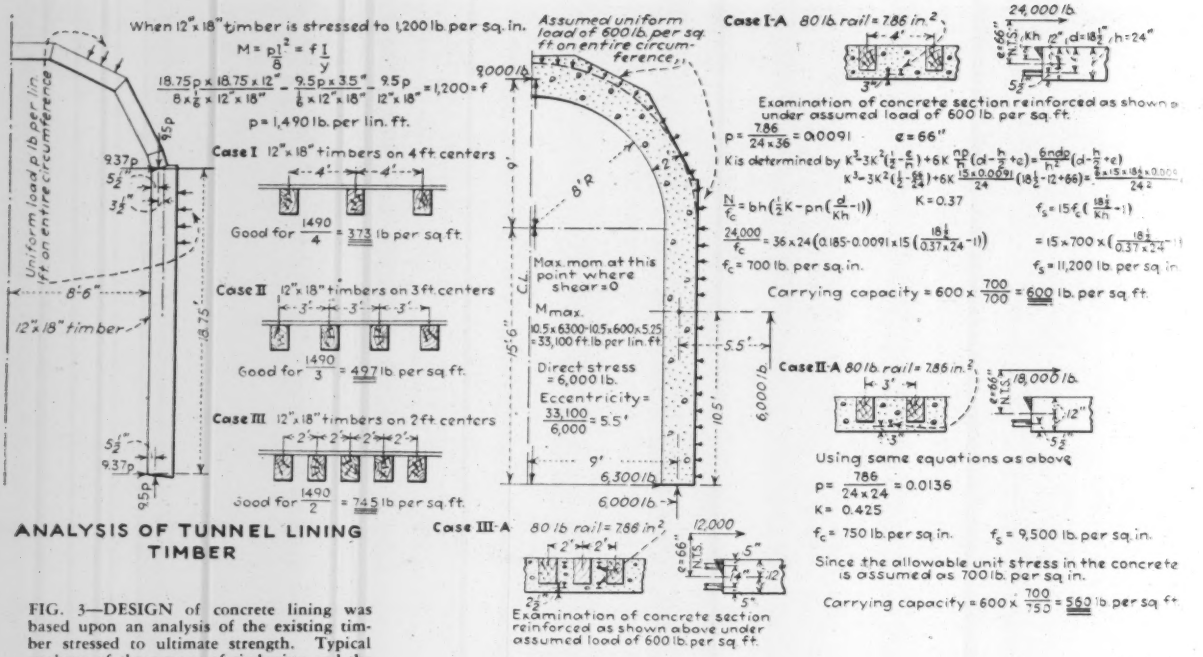

When 12"x18" timber is stressed to 1,200 lb. per sq. in.
M = pl²/8 = fI/y
p = 1,490 lb. per lin. ft.
Uniform load p lb. per lin. ft. on entire circumference
Case I 12"x18" timbers on 4 ft. centers
Good for 1490/4 = 373 lb. per sq. ft.
Case II 12"x18" timbers on 3 ft. centers
Good for 1490/3 = 497 lb. per sq. ft.
Case III 12"x18" timbers on 2 ft. centers
Good for 1490/2 = 745 lb. per sq. ft.
12"x18" timber
8'-6"
18.75'
ANALYSIS OF TUNNEL LINING TIMBER
Assumed uniform load of 600 lb. per sq. ft. on entire circumference
9000 lb.
8' R
C.L.
Max. mom. at this point where shear = 0
Mmax. 10.5x6300-10.5x600x5.25 = 33,100 ft lb. per lin. ft
Direct stress = 6,000 lb.
Eccentricity = 33,100/6,000 = 5.5'
15'6"
10.5'
9'
6,300 lb.
6,000 lb.
Case I-A 80 lb. rail = 7.86 in.²
Examination of concrete section reinforced as shown above under assumed load of 600 lb. per sq. ft.
p = 7.86/24x36 = 0.0091 e = 66"
K is determined by K³-3K²(½-e/h)+6K np/h (d-h/2+e) = 6npd²/h² (d-h/2+e)
K³-3K²(½-66/24)+6K 15x0.0091/24 (18½-12+66) = 6x15x18½x0.0091/24²
K = 0.37
N/fc = bh(½K-pn(d/Kh-1))
24,000/fc = 36x24(0.185-0.0091x15(18½/0.37x24-1))
fc = 700 lb. per sq. in.
fs = 15fc(18½/Kh-1)
fs = 15x700x(18½/0.37x24-1) = 11,200 lb. per sq. in.
Carrying capacity = 600 x 700/700 = 600 lb. per sq. ft.
Case II-A 80 lb. rail = 7.86 in.²
6,000 lb.
18,000 lb.
Using same equations as above
p = 786/24x24 = 0.0136
K = 0.425
fc = 750 lb. per sq. in.
fs = 9,500 lb. per sq. in.
Since the allowable unit stress in the concrete is assumed as 700 lb. per sq. in.
Carrying capacity = 600 x 700/750 = 560 lb. per sq. ft.
Case III-A 80 lb. rail = 7.86 in.²
12,000
Examination of concrete section reinforced as shown above under assumed load of 600 lb. per sq. ft.
p = 786/12x24 = 0.0273
K³-3K²(½-e/h)+12K np e/h = 6np(e/h+2 a²/h²)
K³-3K²(½-66/24)+12K 15x0.0273x66/24 = 6x15x0.0273(66/24+2 7²/24²)
K = 0.43
N/fc = bh(½K+pn(2-1/K))
12,000/fc = 12x24(0.215+(15x0.0273)(2-1/0.43))
fc = 521 lb. per sq. in.
Carrying capacity = 600 x 700/521 = 805 lb. per sq. ft.
fc = 700 lb. per sq. in. fs = 8,100 lb. per sq. in. tension
fs = 5,400 lb. per sq. in. comp.
ANALYSIS OF TUNNEL LINING CONCRETE

FIG. 3—DESIGN of concrete lining was based upon an analysis of the existing timber stressed to ultimate strength. Typical analyses of three types of timbering and the corresponding development of the concrete lining design are shown.

centration and bonding properties of steel in the rail sets were taken into consideration. The small range of temperatures in the tunnel made it unnecessary to consider expansion and contraction stresses in the rail sets.

Construction procedure

At the present time the relining is approaching the final stretches. Equipment and procedure are described as they were observed on an inspection made last summer.

The working conditions are onerous. Extreme caution must be exercised in disturbing the original timbering, and this, coupled with train and smoke interference, makes the relining work slow and tedious. The scheduled daily trains include four passengers and four freights, and extra freights often raise the number of train movements through the tunnel to as many as 22 per day. Passenger trains cause little trouble, for they pass through rapidly, and within 15 minutes after a passage the smoke has cleared out; but the long freights, often with two or even three engines, require considerable time for passing, and their smoke leaves the tunnel fouled for at least 45 minutes.

The work is divided between timber and concrete crews. Removing the timber where necessary, setting the steel rail sets with the required struts to hold the ground, trimming the timbers to be left in place, placing the reinforcing and digging of the drain trenches are all done by the timber crew, leaving only handling of forms and placing of concrete for the other crew. Included in the equipment of the timber crew is a high scaffold car, hauled by a gasoline-motor car.

Removing Timber—The treatment of the timbered sections preparatory to concreting varies widely and follows the carefully-planned schedule formulated from the survey records. Where entire removal is called for and the steel rail sets are to be installed, the original timber sets are taken out a few at a time along with the corresponding lagging and packing.

Removing the timbers is difficult work, even though power saws and augers, chain blocks, jacks and sledges

FIG. 4—STEEL RAIL SETS replaced the original timber in many sections, temporarily holding the ground but ultimately acting as concrete reinforcing.

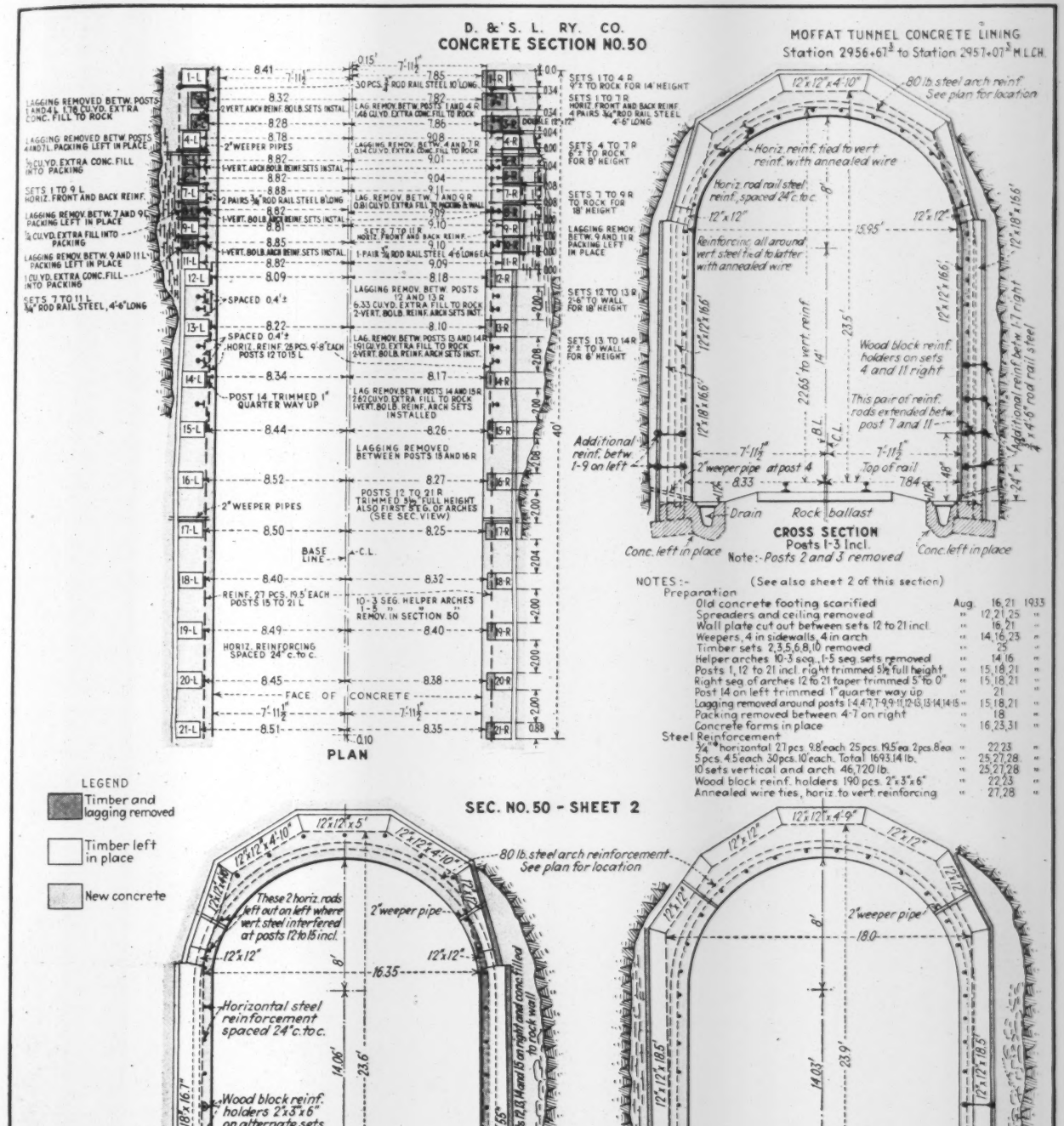

D. & S. L. RY. CO.
CONCRETE SECTION NO. 50
MOFFAT TUNNEL CONCRETE LINING
Station 2956+67 1/2 to Station 2957+07 1/2 M.L.CH.
PLAN
CROSS SECTION
Posts 1-3 Incl.
Note:-Posts 2 and 3 removed
(See also sheet 2 of this section)
LEGEND
Timber and lagging removed
Timber left in place
New concrete
SEC. NO. 50 - SHEET 2
CROSS SECTION
Posts 12-21 Incl.
CROSS SECTION
Posts 4-11 Incl.
Rock Condition
Through section 50, rock is badly decomposed granite, with talc seams running throughout. Rock slacks off fast when exposed to air. Section damp, no trickling of water at any spot in this section. Packing starting to decay. Fungus on packing but not on plumb posts, slightly appearing on lagging in spots
Concreting
Concrete 1:2.16:3.58 mixture; Slump 4 3/4", 5", 7 3/4"; Cylinders 6 taken

FIG. 5—THE POSITION of every piece of timber in the tunnel was carefully plotted on sheets like this, which is the actual record of a 40-ft. section of tunnel, showing ultimate treatment of the timber and concrete.

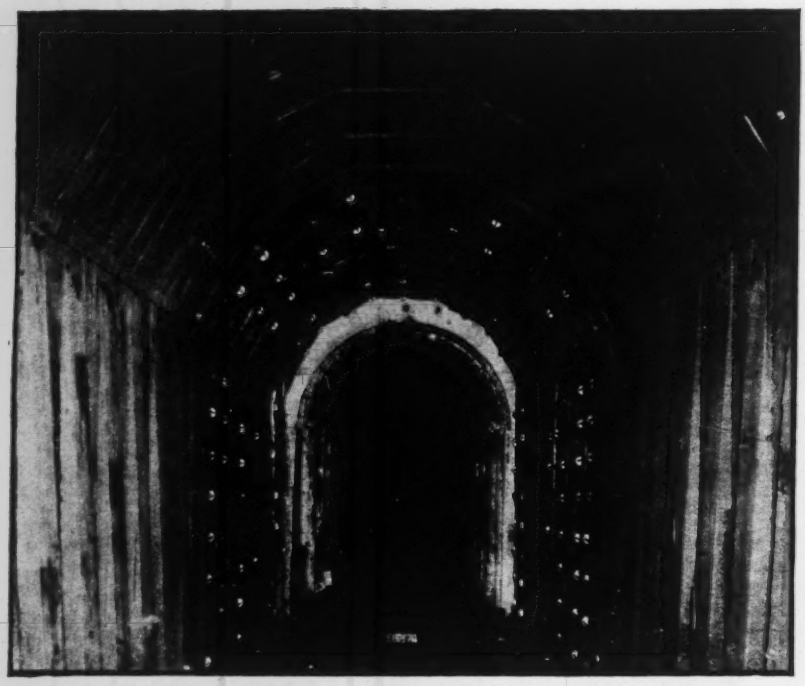


FIG. 6—COMPLETED LINING in background, with the forms still in place. In the foreground is a section of undisturbed original timbering, and between it and the concrete are timbering and rods ready for concreting.

are used to good advantage. As rapidly as the steel sets are erected, struts are placed between steel and rock for the temporary support of the ground.

Where timber is to be left in place, the preparatory treatment consists of removing enough of the lagging and packing to provide for a bond between the rock and the concrete that will assure strength and equilibrium at the springline and in the arch. Sometimes the lagging is cut out entirely, sometimes only in alternate or occasional bays, and again only in small sections at the bottom and at the springline, depending upon the ground conditions. In general, the poorer the ground the more timber is removed.

In all cases the timbers remaining are trimmed to allow for a minimum cover of 6 in. of concrete. Several methods of trimming have been tried, all proving tedious. The most successful method is to bore holes in the face of the timber the required depth with a 2¼-in. power auger, and then cut out the intervening wood with an adze. Where steel-beam wall plates exist, the horizontal web between timbers is burned out to allow for a free flow of concrete from the arch into the side walls. Figs. 2 and 6 show sections of tunnel ready for the forms.

The rail sets consist of two pieces, each extending from the floor to the crown of the tunnel, where they are joined by a bolted splice connection. The cutting, bending and drilling of the rails are done at the railroad's Utah Junction shops at a very low cost. Bending is accomplished by heating 15 ft. of one end of a straight rail length in a blast furnace and then curving it to an 8½-ft. radius around a fixed templet by means of a hoist cable hauled by a tractor.

Special Concrete Plant—In designing the plant to produce 70,000 cu.yd. of concrete, special consideration was given to operating conditions, which required high-capacity production at infrequent intervals. It was plain, for ex[ample] that much time would be consum[ed] waiting for trains to clear the [tunnel] and in getting the concrete to the [point] of placement, in addition to the [time] required for discharge into the [cars]. Also it was evident that there wa[s] chance to cut down the time req[uired] for the trip from plant to form and [back] to the plant again. However, the [effi]ciency of the whole operation co[uld be] increased by reducing to a minimu[m] the time required to mix and load the [con]crete cars at the mixers, and the [plant] was designed with this point in mi[nd].

Because the greater part of the l[ining] lies west of the apex of the tunnel, the concrete plant was placed at the west portal. It consists of three units—a bulk-cement storage plant, a batching and mixing plant, and a concrete-placing plant. Bulk cement, unloaded from box cars by scrapers into a hopper, is elevated to a 550-bbl. steel storage bin by a screw conveyor, then is fed from this bin to the cement weighing batcher in the adjacent mixing plant by another screw conveyor. The batching and mixing plant is of heavy timber construction, containing overhead sand and gravel storage bins (charged by a locomotive crane), weighing batchers and two 1-yd. mixers. From a deep pit below the mixers, concrete is carried up an incline by two skips, which charge an elevated steel-lined wood concrete storage hopper of 221cu.yd. capacity. From this hopper the discharge by gravity into hopper cars for transportation into the tunnel is quick.

Careful analysis of all concrete aggregates has been made. Particular

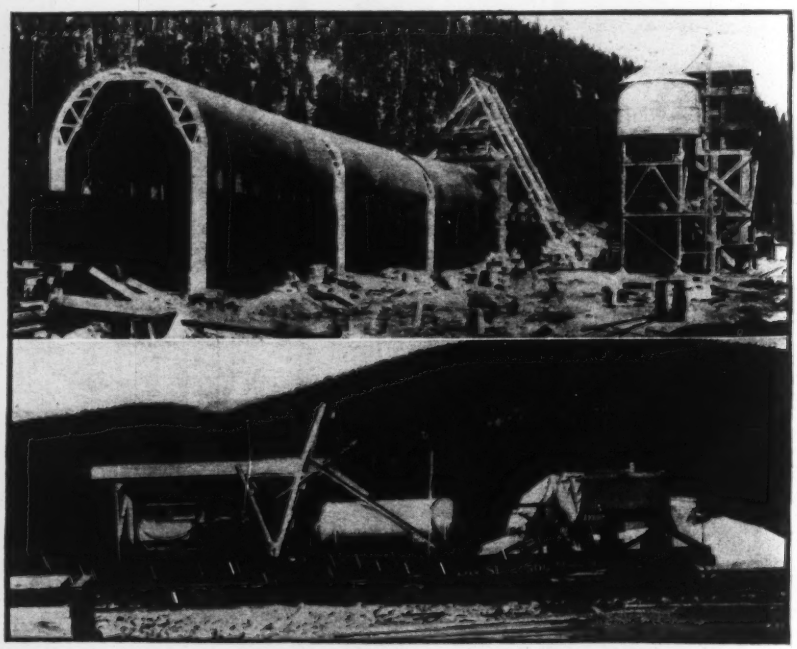


FIG. 7—CONCRETE MIXING AND PLACING was done by special equipment. The top view is the concrete plant at the west portal and some steel-form sections; below is the concrete-placing car, with the cantilevered gun and charging hopper at the left end.

attention has been paid to proportioning by water-cement ratio; test cylinders are obtained from batches of each section, and these are broken at intervals of 3, 7 and 28 days. Cores drilled out of the arch and side walls show that the pneumatically placed arch concrete tests higher than that from the gravity-placed walls; depths of cores substantiate the computed thicknesses of lining. Compressive-strength results at 28 days range from 3,500 to 5,200 lb. per sq.in.

Four sets of collapsible steel forms, two 20-ft. and two 40-ft. sections, are used in various combinations. The forms are of two rigid sections, each forming one side wall and half of the arch, the two sections being hinged at the crown to facilitate stripping. Hinged doors just below the springline permit pouring the walls by gravity. Special cars equipped with air jacks are used to handle the forms; after the forms are set, they are blocked against the rails, and the transporting car is removed. The large freight locomotives traversing the tunnel clear the forms at the side by only 5 in.

Hauling and Placing Plant—The primary requirement that the concrete-placing plant be portable to permit rapid clearing of the tunnel for train passage was met by an ingenious arrangement of the plant on a standard flat car, used in connection with another traveling double-hopper car.

Concrete is transported from the mixing plant to the form by a standard flat car on which two hoppers, set in tandem, are mounted as high as tunnel clearances permit. The rear one of the two hoppers, of 15-cu.yd. capacity, is used solely for filling the side-wall forms. Concrete is discharged by gravity from side chutes through hinged doors in the form. The first concreting operation is to fill the sides for the full length of the form before starting the arch pour.

The forward hopper on the transportation car carries 11 cu.yd. of concrete at a time for the arch section. A ¾-cu.yd. concrete gun, a 500-cu.ft. per min. diesel-driven air compressor, and a 250-cu.ft. capacity air-receiving tank are mounted on another flat car. A cantilever support at the rear end (toward the concrete plant) carries the concrete gun and its receiving hopper, as shown in Fig. 7. The purpose of the cantilever support is to bring the concrete gun directly under the forward hopper of the transportation car when the two cars are coupled, permitting gravity discharge of concrete into the gun-receiving hopper. The concrete discharge pipe, bent into a reverse curve with the discharge end horizontal, is supported by an A-frame and is fastened at the gun end by a flexible connection, which allows the pipe to be lowered when necessary for traveling clearances. From the A-frame the pipe is cantilevered for its full horizontal length. When pouring the arch, the discharge pipes is thrust full length into the key section of the form, and is slowly withdrawn by backing the blower car as the form fills up. A shorter section of discharge pipe is used for the 20-ft. forms.

The gun receiving hopper holds 5 cu.yd., or nearly half of the transported batch. When possible, the blower car is left in the tunnel while the transportation car is hauled back to the plant for another charge. The locomotive assigned to the concrete train has been equipped with extra air pumps to augment the supply of air from the diesel compressor for blowing the concrete and for operating the air jacks on the form-moving car.

Concrete Haul—The average round-trip length of haul from the concrete plant to the section east of the apex is 9.82 miles, requiring about 40 min. The average haul east of the original concrete section is 6.26 miles, which requires 25 min. for the trip. West of the fault section the average haul is 2.61 miles, requiring only 11 min. for transportation both ways and for discharge of concrete.

The regular shift of the concrete crew is twelve hours, from noon to midnight. In this half of the day, train traffic is the lightest, though often extra train movements run a normal 10-hour pour of 170 cu.yd. (40 ft. of form) into considerable overtime. Occasionally extra trains delay start of concreting until late afternoon, and often the crews wait for hours at a time before they can get into the tunnel.

Working conditions inside the tunnel are unpleasant; almost always the hole is smoky, even though the ventilation fans are kept going full speed while concreting is under way. At this altitude (9,200 ft.) the ventilating air is a cold blast, regardless of season of the year, traveling at high velocity. Soot, smoke, diesel oil and fumes, water and spattering concrete fill the air. Knowing their time is limited until the next train chases them to cover, the crew work like mad while work is possible. This feverish activity in the dim smoky light amid the crashing of the concrete blower, popping of the diesel compressor and the racing of the locomotive air pumps is about as near bedlam as a construction job ever gets. Yet despite the unfavorable working conditons, a steady progress of 40 ft. of completed tunnel per day has been maintained.

Direction

The lining work was planned and is being carried out under the direction of W. C. Jones, chief engineer of the Moffat Railroad. J. G. Young is engineering inspector, and Theodore Keen is general foreman.

Sewerage and Sewage Disposal in a South African Town

TRADE WASTES, domestic sewage and stormwater runoff are collected individually in the new sewerage system installed by the town of Paarl, situated on the Berg River, 36 miles north of Capetown in South Africa, according to a report printed in the Oct. 18, 1935, issue of *The Engineer*.

A large proportion of the factory wastes consists of strong spent wine from six distilleries, and local experience has shown that very small quantities of this material mixed with domestic sewage make the resulting mixture a very difficult liquid to purify. This led to the decision to provide a double system of main sewers and separate treatment. The sewers are of cast iron with lead-calked joints.

Factory wastes are given five hours' detention in a mechanically cleaned clarifier, and the effluent, amounting to 300,000 gal. per day, is discharged on 4 acres of porous ground, which has been divided into ten plots. These beds are used in rotation for one week, and there is no trouble with silt deposits or clogging. The sludge is pumped to underdrained sand-drying beds, and after four weeks it is dried sufficiently so that it can be raked into piles and burned.

Domestic sewage, amounting to 750,000 gal. per day, from a contributing population of 30,000, is coarse-screened, passed through a grit chamber and then given four hours' detention in two preliminary tanks provided with mechanical sludge removers. After clarification, the sewage is treated by the activated-sludge process with four hours of aeration carried out by means of mechanical surface aerators combined with compressed diffusion through drilled horizontal pipes located halfway below the liquid surface.

The effluent coming from the aeration tank is settled for a two-hour period in a sedimentation unit and then passed to a dosing tank, which periodically discharges to four 90-ft.-diameter percolating stone filter beds. Final sedimentation and chlorination complete the treatment process, and the highly purified and sterile effluent is used for irrigation purposes.

The sludge from the various domestic sewage sedimentation tanks is pumped to a battery of two digestion units, and after decomposition it is dried on underdrained sand beds.

Extensive Pioneer Roadbuilding in Progress in Canada

Active progress in filling gaps in the Trans-Canada Highway and long pioneer roads into northern mineral lands are impressive steps in extraterritorial highway development

EXTENSIVE roadbuilding has been undertaken this year by the dominion and provincial governments to complete a trans-Canada through highway and to give access to distant interior territory in which mining has been rapidly developing or is of potential promise. At present the most active work is in the provinces of Quebec and Ontario. Here a 150-mile line into the Abitibi district has been surveyed and some contracts have been let; another about as long to the Chibaugamau gold and copper prospects west of Lake St. John is being actively planned by the Quebec road department, and Ontario has begun construction on the 300-mile gap in the trans-Canada highway north of Lake Superior. All of these operations have been hastened somewhat since they fit well into a relief-works program, but all are also planned territorial-development projects long contemplated by the Canadian governments. Few countries have a comparable pioneering road development that is being as actively advanced toward actual construction.

The following accounts of plans and progress are from information furnished to representatives of *Engineering News-Record* by the Canadian provincial highway departments. At present only the planned work can be outlined; certain of the projects await decision between alternate routes, and contract work has not been developed sufficiently for definite description. The accounts that follow are project descriptions.

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Closing the Ontario Gap in the Trans-Canada Highway

By A. C. Jameson
Toronto Correspondent, Engineering News-Record

INVOLVING an expenditure of more than $2,500,000, contracts have been awarded recently by the Ontario government for constructing a 105-mile link in the Trans-Canada highway, from Schreiber to White River. At the present time, negotiations are under way between the dominion and the province for the designation of the remainder of the route through Ontario. Alternative proposals, to build the road from White River to Sault Ste. Marie, a distance of about 200 miles, or to build it from White River to Hearst, a distance of about 130 miles, have been submitted to the dominion government. As soon as either is accepted, the provincial authorities, it is understood, are prepared to call for tenders and proceed with the work.

At either Sault Ste. Marie or Hearst (Fig. 1) a road extended easterly from White River would meet the already-completed highway, built to Trans-Canada Highway specifications. Delay in designating either route results from indecision as to whether the highway in this section is to be primarily a tourist or a colonization road. Rounding the east end of Lake Superior and passing through one of the most rugged parts of the continent, the route from White River to the Soo would afford, it is claimed, unparalleled tourist attractions. The route from White River to Hearst, on the other hand, would serve important and growing farming and mining communities.

When it has been completed in Ontario, the Trans-Canada Highway will stretch unbroken except for 57 miles crossing the Rocky Mountains, from Halifax on the Atlantic, to Vancouver, on the Pacific Ocean. Its length will be approximately 4,500 miles.

Trans-Canada plan

Although the idea of the Trans-Canada Highway was conceived many years ago, it was not until 1919 that it began to take form. When British Columbia joined the Dominion of Canada in 1871, one of the express conditions of the union was the construction of a road across the prairies to link the coast province with the east. For decades the promise went disregarded, but in 1919 the dominion government passed the Canada Highways Act, by which a sum of $20,000,000 was set aside for the purpose of assisting the provinces in road construction. Under the inspiration of the late A. W. Campbell, chief commissioner of highways under this act, strong impetus was given to the linking up of the road systems of the provinces. Finally a definite scheme was adopted, which was calculated to lead to the completion of a Trans-Canada Highway.

Construction costs have since been shared equally by the dominion and the provinces. No statement of the full expenditure to date is available, but it may reasonably be estimated that a total of $20,000,000 has been spent since 1931, when the project began to be pushed as an unemployment-relief measure. An even greater sum will be required to bring the highway to completion, this estimate being based not on an all-paved road but on serviceable hard-surfaced construction.

All new construction has been carried out to standard specifications of the dominion government. The roadway is 30 ft. wide, with minimum grades not to exceed 10 per cent, and clear sight distances of 500 ft. Old roads incorporated in the highway are being improved to comply with these requirements.

Work completed and required

In Nova Scotia there are 292 miles of the Trans-Canada Highway, mostly improved gravel road that is being paved in stages. From the Nova Scotia boundary the highway is carried 410 miles through New Brunswick north through Sackville and Dorchester, to Moncton, thence west to Saint John, and again north along the Saint John River to Fredericton and Woodstock, to the Quebec boundary, near Edmundston. Most of the surface in this province is improved gravel, which is being replaced gradually with pavement.

In the province of Quebec the route runs north from the New Brunswick boundary to Rivière-du-Loup, Levis and Quebec, and thence along the north shore of the St. Lawrence River to Montreal and the Ontario boundary. Out of a total of nearly 500 miles in this province, about 300 miles have been paved, representing the largest amount of pavement on any provincial section

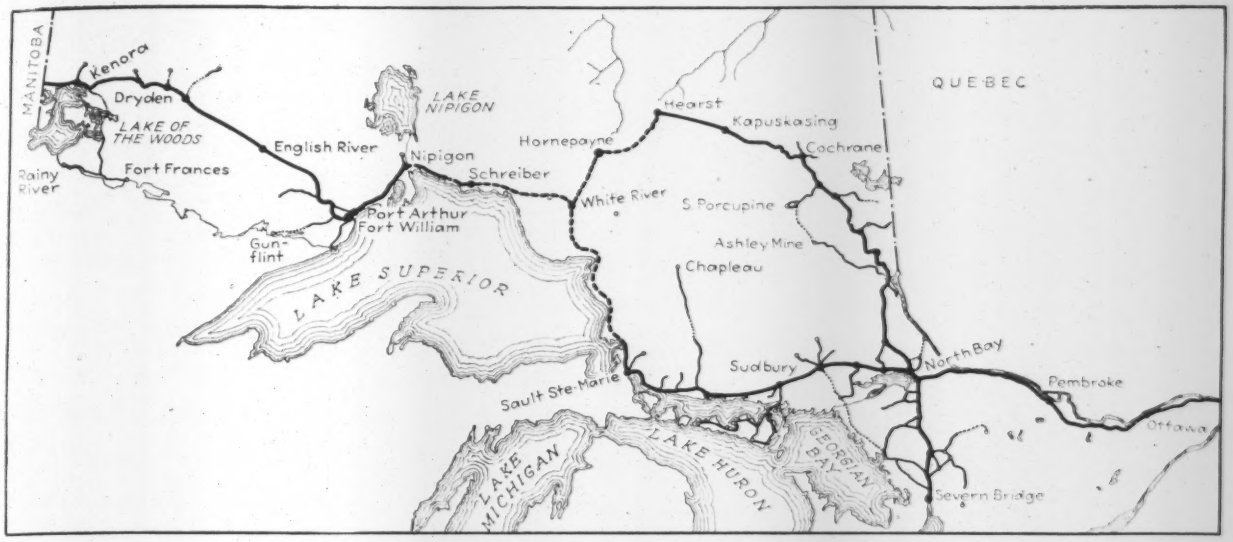

FIG. 1—WESTERN ONTARIO highways, depicting gap north of Lake Superior now being closed to complete the 4,500-mile Trans-Canada Highway, except for 57 miles through the Rocky Mountains.

of the highway. The Trans-Canada work in Quebec consists largely of widening and paving operations on already-existing roads.

The highway in Ontario is divided into six sections. The most easterly runs from the Quebec boundary following the Ottawa River to Pembroke, and is under the control of the Ontario Department of Highways. This section is completed. The remaining five sections are administered by the Ontario Department of Northern Development.

The second section runs from Pembroke west through the Ottawa Valley to Mattawa and North Bay. This section is part paved and part gravel. Section 4 will commence at Sault Ste. Marie and run north along the shore of Lake Superior to White River, and is the part for designation of which negotiations are being carried out. As an alternative to this routing, the highway may follow an existing road north from North Bay to New Liskeard and Cochrane and west to Hearst, where a gap would be filled in to connect it with section 5 at White River.

Section 5 runs west from that point through Schreiber, Nipigon, Port Arthur and Fort William and parallels the Canadian Pacific Ry. to Dyment, Dryden, Vermillion and Hawk Lake. Contracts have been let for grading from White River to Schreiber, while the remainder of the section is being surfaced, with a large bridge to be put in at Nipigon. Section 6 runs from Vermillion to the Manitoba boundary, and is being surfaced with two large bridges to be put in at Keewatin.

From the Ontario boundary the Trans-Canada is carried across Manitoba, through Winnipeg to the Saskatchewan border, a distance of 341 miles. Of this about 35 miles are paved, and the rest is gravel. Through Saskatchewan the highway passes from the Manitoba boundary to the Alberta boundary by way of Regina and Moose Jaw, a distance of 463 miles. This section has a good gravel surface.

The Alberta section of the highway extends from the Saskatchewan boundary for 355 miles to the British Columbia boundary at the Great Divide, by way of Medicine Hat, Calgary, Banff and Lake Louise. Fifty miles of this route lie within Banff National Park.

The section of 305 miles within the jurisdiction of the Alberta government is good gravel. British Columbia contains 680 miles, and 623 of these are open to traffic, 137.13 being surfaced with concrete or asphalt; 57 miles are still to be built through the Rocky Mountains from Revelstoke to Golden.

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Quebec Starts Roadbuilding to Its Rich Mineral Lands

By Robert F. Legget
Montreal Correspondent, Engineering News-Record

THE PRESENT improved road system of Quebec, Canada, is confined to the St. Lawrence plain and is for the most part on the south side of the river. To the north lies enormous territory largely undeveloped except in the Abitibi mining region, and here a number of highways have been developed. No direct access to this group of roads has existed in Quebec territory; travel has had to go west into Ontario and then north on the highways of this province and finally loop back eastward to the Quebec mining region. Similarly there is, west of Lake St. John and more directly north from Montreal, the potential gold and copper mining Chibougamau district, which has no road connections, although Lake St. John itself can be reached by a road along the Saguenay and another north from the city of Quebec.

Reference to the accompanying sketch map (Fig. 2) will show that at present there is no highway connection, within the province of Quebec, between the main-road system of the province and the roads located in the northwest corner of the province, adjoining the C.N.R. transcontinental line. This isolated area is a rapidly growing mining district of constantly increasing importance, in which are located such well-known properties as the Noranda copper-gold mine, and the Treadwell Yukon and Siscoe gold mines. Access to the area from Montreal by road is therefore, as stated, only possible through Ontario.

Surveys have been conducted, and are now complete, for the location of a highway to connect up the two most northerly highways of the main-road system with the southern extremity of the existing group of roads in the northwest corner of the province. The latter extends from Senneterre (on the C.N.R.) as far as the Treadwell Yukon mine; the two former are respectively the road from Montreal through Ste. Agathe to Mont Laurier, thus extending far into the Laurentian Mountains, and that from Ottawa up the valley of the

Gatineau River to Maniwaki, practically all of which is in the mountain area.

In view of the rugged nature of the Laurentian-Mountain country, the large number of lakes and streams with which it is studded and the lack of any development work at all in the area, the location of the roads has been a matter of unusual complexity, necessitating extensive and detailed survey work. As indicated, this is now complete.

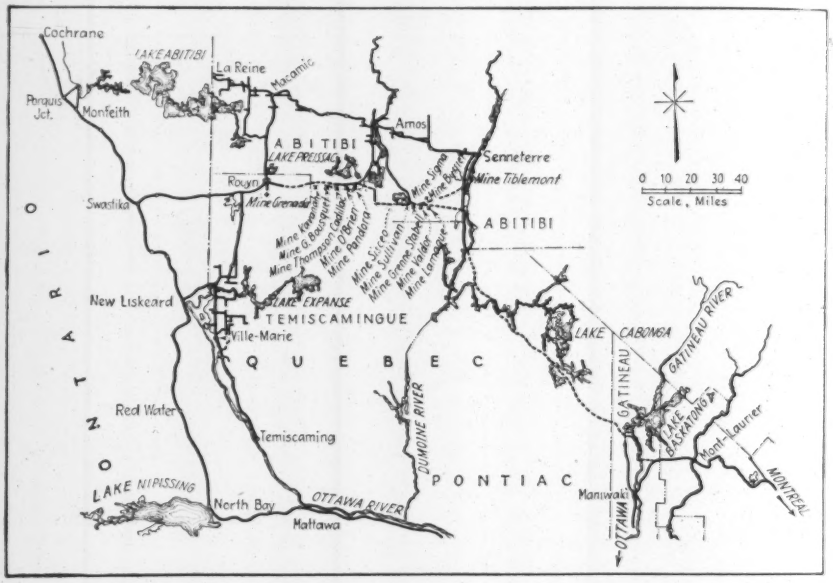
The general route selected is shown by Fig. 2, although it will be realized that this is no more than a general indication, since the actual route, in view of the nature of the ground traversed, is most tortuous. In keeping with the general policy of the department of roads, no effort has been spared in obtaining the best possible location. The limiting gradient is generally 7 per cent, and curvature is nomally limited to 6 deg., except in a few special locations where 11-deg. curves have to be used, the corresponding maximum gradient being 10 per cent. Further, while initial surfacing will be gravel only, all subgrade and substructure work will be designed and executed in the first instance as for a first-class highway, thorough consolidation of fills, etc.; it is obtained in this way during the initial use of the road pending the development of economic conditions that will justify the completion of the surfacing. Initial clearing, earthworks and graveling, including all bridges, culverts, etc., are estimated to cost up to $15,000 per mile; it is for this work, for a part of the route, that contracts have recently been awarded. A length of 107 miles is now under construction, leaving 40 miles for which tenders will be called in the near future.

Other northern road work

Two other projects for the northern part of the developed section of the province are under consideration. The location of the first of the areas in question is not included in the accompanying sketch map, but it will be found to the west of Lake St. John at the head of the famous Saguenay River; it is known as the Chibougamau district. This is a potential gold and copper-mining area of importance. Initial suggestions have been made that connection would naturally be made with existing roads in the Lake St. John area, of which Chibougamau has always been regarded as an adjunct. Another suggestion, however, has been advanced before the provincial legislature, based on the fact that, strangely, Chibougamau is west of Montreal, and not to the east of it. Access is therefore suggested by way of Montreal, using the Montreal to Mont Laurier road, now reaching as far as Tapani, this necessitating only 120 miles of new road. The matter is still being studied, although there are many other major factors to be considered, especially as Quebec City, more to the north than Montreal, is actually nearer to Chibougamau than is the latter.

The pulp and paper-making town of Temiskaming, located at the southern end of the lake of the same name, which constitutes part of the boundary between Ontario and Quebec, is another isolated locality, access to it being possible at present only by way of the Canadian Pacific Ry. through Mattawa. Strong representations have been made to both of the provincial governments concerned, by the town authorities, urging completion of the two short stretches of road that will give the town access to North Bay, Ont., and Ville Marie, P.Q., with consequent advantages to all three communities, especially as Temiskaming has now a population of over 3,000. The first of these roads is a 12½-mile stretch from Temiskaming to Jacko, in Ontario, giving connection with a main highway out of North Bay on which $175,000 has already been spent. The second is the completion of the highway that already exists for 26 miles south of Ville Marie, a stretch of 54 miles in all, all in the Province of Quebec, paralleling the lake, which would connect Temiskaming with the thriving communities, in both provinces, which exist at the northern end of the lake. This highway is now under contract for a stretch of 10 miles, and tenders for the balance are expected to be called shortly.

FIG. 2—WESTERN QUEBEC HIGHWAYS, depicting the general route of the 150-mile pioneer road to the Abitibi mining district.



New roads near large cities

Two proposals for highway construction near the cities of Quebec and Montreal respectively, of unusual interest though of more urban character, call for mention. The beautiful and historic Island of Orleans, located in the River St. Lawrence close to the city of Quebec, was this summer connected with the mainland when, on July 5, the new $3,000,000 suspension bridge named after the island was opened to traffic. Foundation procedure at this structure was described in *Engineering News-Record*, March 15, 1934, p. 356. The provincial legislature has therefore voted $150,000 for the improvement and extension of the roads on the island and for the construction of a park. This work is now under way.

The approach to the city of Montreal, from the west, is again receiving attention, the proposed Trans-Island Boulevard having been reconsidered by the Metropolitan Commission for the Island of Montreal. Another proposal, however, has been advanced for eradicating the 12-mile stretch of sinuous curves along the shore of Lake St. Louis, from Ste. Anne de Bellevue in toward the city, which is so distressingly familiar to all who have thus approached Montreal. The provincial department of roads has surveyed and already staked out a new 80-ft.-wide approach road, paralleling the C.N.R. main line to the west, between Lachine and Ste. Anne de Bellevue. This proposal, although it is not intended to replace the Trans-Island Boulevard, has the advantage of giving a straight access road to the city without removing it far from lake-shore municipalities, the authorities of all of which have expressed themselves in favor of the proposal. Many and varied interests are involved in both proposals, discussion of which is proceeding at present.

Hon. J. E. Perrault is minister of roads in the Quebec government, Lt. Col. J. L. Boulanger is deputy minister, and Alphonse Paradis is chief engineer.

Soil-Loading Machine Tests Four Samples at Once

New apparatus at Harvard soil-physics laboratory permits simultaneous test of consolidation, permeability, compression and shear or of any combination of these four tests

By Philip C. Rutledge

Research Assistant in Soils Mechanics, Graduate School of Engineering, Harvard University, Cambridge, Mass.

IN THE COMPARATIVELY NEW research realms of soil mechanics and soil physics the testing apparatus is still the problem and product of the laboratory. This situation was indicated in the article on testing practice at the laboratory of the Bureau of Public Roads in *Engineering News-Record*, Nov. 8, 1934. Again the large apparatus at the Massachusetts Institute of Technology used by Terzaghi in his earth-pressure tests (*ENR*, Sept. 29, 1932) was the product and design of the laboratory worker. As the latest creation there is the universal soil-loading machine developed at the soil-mechanics laboratory of Harvard University and described in the following article. This last machine is a truly creative work in advancing the speed of soil-testing laboratory processes. It is, too, a machine that is within the means in cost of most permanent laboratories or even for field laboratory installation on large construction operations. The device is a credit to the inventiveness of the testing engineer, and its description here deserves attention.

—EDITOR.

DURING the last three years, in the soil-mechanics laboratory of the Graduate School of Engineering, at Harvard University, extensive studies and research have been devoted to the design of new testing apparatus. This equipment contains so many decided improvements that it represents a real progress in soil testing. Although the apparatus was designed to attain the greatest possible accuracy, it has been found, upon its completion, to be much less expensive and much easier to operate than the apparatus hurriedly developed during the earlier years of soil mechanics. For this reason it could very well be used in laboratories for instruction purposes and in field laboratories of a somewhat permanent character.

In recent years four tests have become generally accepted as necessary for all soils investigation and research. These four are: the laterally-confined compression or consolidation test, the permeability test, the unconfined or partly-confined compression or compressive-strength test, and the direct-shearing test.

The most important single soil test, the consolidation test, with correlated determinations of the permeability, is indispensable in the solution of problems of the amount, rate and uniformity of settlements, problems which are confined almost exclusively to the very fine-grained impervious soils such as silts and clays. The compressive-strength test and the direct-shearing test measure directly the strength of the soil. For this reason their results are essential in the solution of problems of stability of slopes and of structures holding back earth. In addition, we must include, in studies of these latter problems, the permeability test, in so far as the flow of water through soils affects the stability of structures such as retaining walls.

General design considerations

It was desired to perform the four major soil tests on one testing bench and frame: (1) to conserve space; (2) to conserve the time of the operators by having all tests concentrated at one place; and (3) to make the entire apparatus as inexpensive as possible by utilizing one frame for all tests and by designing the load apparatus to be interchangeable between the various tests.

Another very important requirement was that the apparatus be free from vibration. Vibration seriously affects soil structures during test, particularly the structures of loose, fine-grained, cohesionless or weakly-cohesive soils such as fine sands and silts; if the vibration is not eliminated, very misleading results are obtained from all soil tests on such materials. Vibrations come from the building housing the apparatus due to near-by traffic; and from the floor of the laboratory due to movements of the operators. Elimination of the first type is, of course, dependent on the site of the laboratory. Floor vibrations can be eliminated by having the floor upon which the operators stand and walk entirely separate from the apparatus supports. This may be accomplished when installing field laboratories by carrying the apparatus frame on foundations independent of the floor; for laboratories housed in permanent buildings the apparatus can be suspended from beams carried by the walls or columns of the building, particularly if the building is constructed with relatively heavy walls or frame and relatively light floor systems.

The experience of a number of investigators with various types of testing apparatus has led to the conclusion that the type in which the load is applied by means of a single, or combination of, lever arms, using knife-edges to transmit all forces into and out of the lever arms, is the most satisfactory for soil tests. Such apparatus is of the constant-stress type. That is, the stress is the controlled factor, and the deformation or strain is measured as a function of the stress and of time. The constant-strain type of loading apparatus, in which the strain is the controlled factor and the stress the dependent variable (for example, the ordinary hydraulic testing machine) produces results in almost all soil tests which are extremely difficult to evaluate. It is almost impossible to control the time factor in any logical way, and constant attendance of the operator is necessary during the test in order to have a complete picture of the stress variations.

For all tests carried out on the universal soil-loading machine the former type of loading apparatus is used. Load is applied through counter-balanced lever arms supported on knife-edges, the actual load increments being obtained through weights on hangers or through load travelers moving along the lever arms or the beams. An essential point in designing apparatus of this type is: the points of application of all forces must be at all times on the center line of the beams so that changes in the angle of inclination of the beams during tests will have no effect on the load applied to the sample, since the ratios of the moment arms will not change.

The final general consideration in the design is simplicity of operation. Automatic application and control of application of load are important: (1) the mechanism for applying or increasing the load can be so designed as not to introduce additional forces into the beams; (2) the personal equation can be eliminated from the test itself, thereby confining its effect to the preparation of the sample; and (3) the necessity of having two operators to perform a single soil test is eliminated.

The universal soil-loading machine

The frame of the universal soil-loading machine is suspended from 12-in. steel I-beams carried by the masonry walls of the building housing the laboratory; thus it is entirely independent of the floor. The frame consists of steel channels and I-beams designed for rigidity and negligible deflections. It was fabricated and assembled with great care, to insure that all horizontal members would be parallel and exactly horizontal. This was made necessary by the testing processes, which require that the loads be applied in planes normal to the true horizontal and vertical. The testing bench, which projects somewhat to the front of the frame (see Fig. 1), is formed by two parallel 8-in. I-beams; its location renders the apparatus for the various tests easily accessible and simplifies the observation of all tests in progress. The remainder of the frame serves only to carry the fulcrums of the various loading and counterweight beams and the controls and accessories to the loading apparatus.

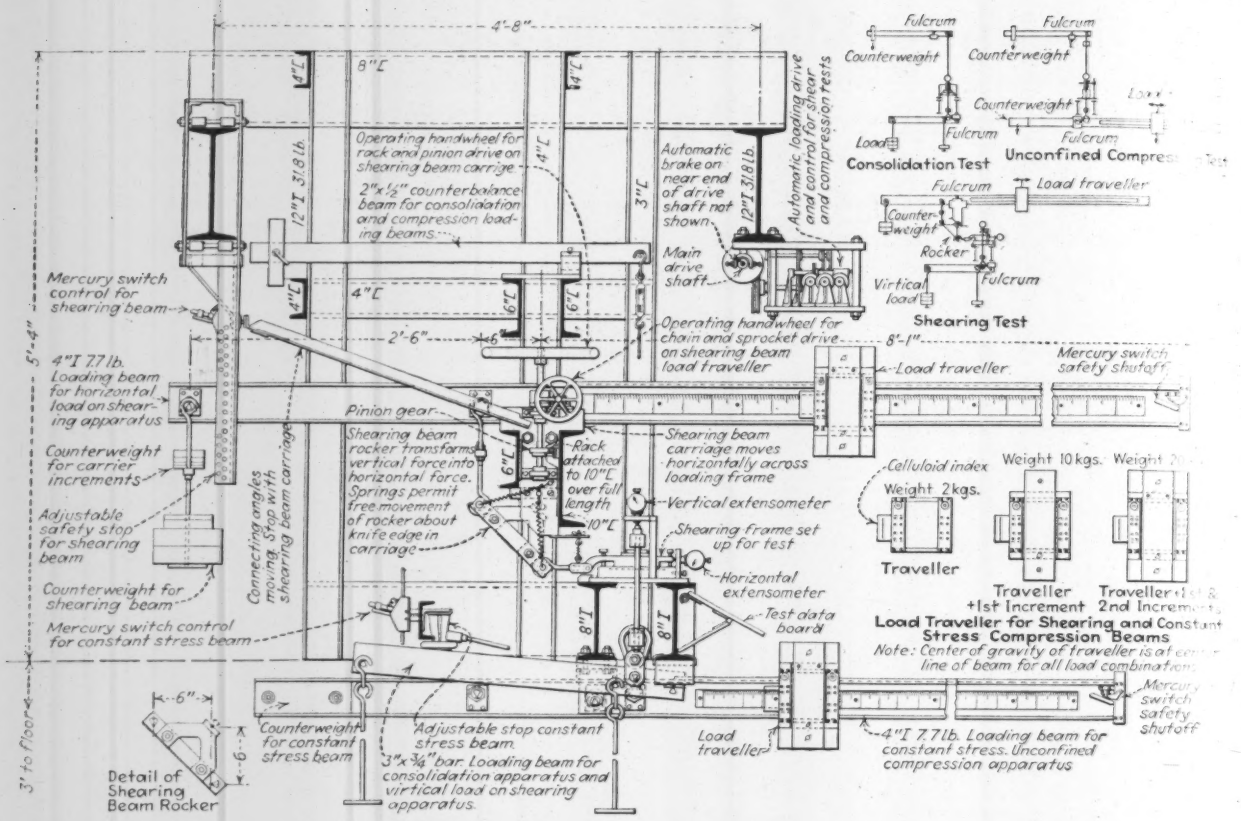

4'-8"
8"I
12"I 31.8 lb.
Operating handwheel for rack and pinion drive on shearing beam carriage
2"x½" counterbalance beam for consolidation and compression loading beams
Automatic brake on near end of drive shaft not shown
Automatic loading drive and control for shear and compression tests
Main drive shaft
Mercury switch control for shearing beam
4"I 7.7 lb. Loading beam for horizontal load on shearing apparatus
Counterweight for carrier increments
Adjustable safety stop for shearing beam
Counterweight for shearing beam
Mercury switch control for constant stress beam
Connecting angles moving Stop with shearing beam carriage
Pinion gear
Shearing beam rocker transforms vertical force into horizontal force. Springs permit free movement of rocker about knife edge in carriage
Rack attached to 10"I over full length
Shearing beam carriage moves horizontally across loading frame
Vertical extensometer
Shearing frame set up for test
Horizontal extensometer
Test data board
Operating handwheel for chain and sprocket drive on shearing beam load traveller
Load traveller
Mercury switch safety shutoff
Celluloid index
Weight 2kgs.
Traveller
Weight 10kgs.
Traveller +1st Increment
Weight 20kgs.
Traveller 1st & 2nd Increments
Load Traveller for Shearing and Constant Stress Compression Beams
Note: Center of gravity of traveller is at center line of beam for all load combinations
Fulcrum
Counterweight
Load
Consolidation Test
Unconfined Compression Test
Load traveller
Rocker
Vertical load
Shearing Test
5'-4"
3' to floor
6"
Detail of Shearing Beam Rocker
Counterweight for constant stress beam
Adjustable stop constant stress beam
3"x¾" bar. Loading beam for consolidation apparatus and virtical load on shearing apparatus
Load traveller
4"I 7.7 lb. Loading beam for constant stress. Unconfined compression apparatus

FIG. 1—SECTION showing lever arrangement of the universal soil-loading machine of the soil-mechanics laboratory of the Graduate School of Engineering at Harvard University.

Figs. 1 and 2 show clearly the details of the frame and the manner in which the various apparatus are mounted upon it.

Consolidation Test—The apparatus for the consolidation test is loaded by weights on hangers which are parts of simple systems of levers and knife-edges, completely counterbalanced. The point of interest in this loading system is that the entire system is counterbalanced, including the bearing plate, which transmits the load directly to the upper porous stone of the consolidation device. The bearing plate is suspended from the loading cross-bar by four springs and, with the ball connection, a flexible connection is provided that permits the measured load applied to the sample to begin at zero and to return to zero on the release of load. This feature is necessary to obtain complete and accurate compression diagrams. The same system of levers and weights on hangers is used to obtain high normal pressures on shearing tests. The schematic diagrams in Fig. 1 show the loading arrangement for this test as well as for the compressive-strength test and the direct-shearing test.

Horizontal Load—For the horizontal load on direct-shearing tests and for loading compressive-strength tests it is necessary to determine accurately the failure load or load at which sudden deformation or change in shape occurs. To accomplish this, some form of a gradually increasing load is necessary. The type used on this apparatus is a load which increases at a uniform rate, this rate being variable over a wide range and being known with considerable accuracy. For this purpose the long loading beams seen in Fig. 1 are used. Load travelers, the weight of which can be varied depending on the maximum load required, move longitudinally out along the beams, increasing the load on the sample by increasing the lever arm. On the beams three scales of applied load correspond to the three weights of load traveler shown in Fig. 1.

The travelers can be moved manually by means of hand wheels that are mounted on the rigid frame of the apparatus, or they may be moved out on the beam by means of the automatic drive.

Compression Test—The loading beam for the compressive-strength tests is located beneath the beams forming the testing bench. A counterweight on the beam itself balances it about the fulcrum, which is bolted to the lower flange of the rear beam of the testing bench. In addition, a counterbalance system similar to that used for the consolidation loading beams carries the weight of the beam and forces the knife-edge to bear on the fulcrum at all times. A stop, controlling the maximum motion of the beam, can be adjusted by means of a handwheel (shown in Fig. 2) located at the front of the testing bench just below the operating handwheel for moving the load. The operator has all the controls for this test readily available with out moving from the position from which he can observe the sample.

Shear Test—The shearing beam, located above the testing bench, is balanced about a fulcrum mounted on the shearing beam carriage. This carriage, riding on and between two channels (Fig. 1), can be moved horizontally, by means of a rack and pinion drive, to any position along the testing bench. Thus it is possible to utilize the one beam for applying horizontal load to any desired shearing box, while a number of other boxes may contain samples consolidating under normal loads. These other samples, in turn, are tested with the same loading apparatus. The load traveler, which moves along the beam, develops a vertical force beyond the fulcrum. This vertical force is transformed into a horizontal force by the rocker seen in the detail in Fig. 1. The rocker rotates about a fixed knife-edge in the shearing-beam carriage. A coupling linkage transfers the horizontal pull from the rocker to the upper frame of the shearing box.

Naturally great care must be taken to be sure that the horizontal force from the rocker is exactly in the plane of separation between the two sections of the shearing box. This is accomplished

by having the lower knife-edge of the rocker, in its neutral position, exactly at the elevation of the plane of separation. This apparatus is extremely accurate for horizontal forces from 5 kg. to the maximum of 280 kg. For failure loads less than 5 kg. the accuracy of this heavy equipment is not satisfactory, and a special loading apparatus designed for very light loads is used. The shearing beam is provided with an adjustable stop that limits its maximum motion. This stop, which also includes a mercury switch control for the shearing tests, is connected to the shearing beam carriage and moves horizontally with it. Vertical load is, in most cases, applied to the sample by means of a loading cross-bar and weights on a direct hanger, although for very heavy vertical loads, as has been pointed out before, the loading beams of the consolidation loading apparatus can be used.

Loading control

For most tests on the compressive-strength and direct-shearing apparatus the load travelers are moved along the beams by an automatic drive. This drive consists of two constant-speed electric motors, rated at 1,750 r.p.m. and 1 r.p.m. respectively, which can be used interchangeably with the gear train. The various combinations of gears in mesh, motor used and weight of load traveler make available 75 different rates of load application, varying from 10 kg. per second to 0.003 kg. per hour. This wide variation is primarily for the purpose of investigating accurately the effect of the rate of application of the horizontal load on the shearing resistance of cohesive soils. The various rates of load application have been checked carefully and are as accurate as it is possible to read the total load on the scale on the beam. This accuracy simplifies the operations required during test, inasmuch as the operator needs only to read his stopwatch and the extensometer dials, computing the amount of horizontal load applied, at any point in the test, from the elapsed time.

The last-driven shaft of the gear train is connected by a chain and sprockets to a main drive shaft, which is located about over the operator's head as he stands at the testing bench. Connections from this shaft to the shafts on which are mounted the sprockets moving the travelers along the beams are made by light chains and sprockets. In addition, there is mounted on the main drive shaft an automatic brake operated by a solenoid that is in the motor circuit. This brake stops the load exactly at the time the motor circuit is broken. To obtain accurately the failure load in a rapid test or in a very slow test, should the sample fail when the operator is not present, some means of breaking the motor circuit automatically at failure is required. To perform this task, mercury-switch controls are used. Failure of the sample is accompanied by a small rotation of the loading beam, sufficient to actuate the mercury switch, which breaks the circuit. Additional mercury-switch controls are mounted at the ends of the loading beams, to shut off the driving mechanism before the load traveler hits the end plates of the beams.

The volume-change characteristics during shear of most materials are fairly well known. Therefore, a large percentage of the shearing tests being run on this apparatus are for the purpose of obtaining only the failure load. A reading of the expansion or compression of the sample at failure is made merely as a check on the reliability of the test. For these tests it is necessary for the operator only to set up the sample in the shearing box, make the connection to the rocker, and start the loading apparatus at the desired rate of load application. Then at any convenient time after the sample has failed he can obtain the results of the test, without having been in attendance during its progress.

A careful study of Fig. 2, the front elevation of the machine, will show the methods of construction and operation of much of the apparatus not discussed in detail. The driving motor used with the automatic drive for rates of load application above 1 kg. per hour is a $\frac{1}{8}$-hp. induction motor. This motor is not shown on the drawings. Its operation is accompanied by slight vibrations, and for that reason it is mounted on a frame carried by the floor. The only connection to the soil-loading machine is through a light belt to the gear train. Thus the motor vibrations do not enter the frame of the loading machine or affect the tests.

Since the construction of this apparatus it has come to the attention of the author that there is on the market a motor constructed for laboratory use which provides a wide range of speeds with a reasonable degree of accuracy. The use of such a motor on future apparatus of this type would reduce the size and cost of the gear train necessary to obtain suitable variations in rate of load application.

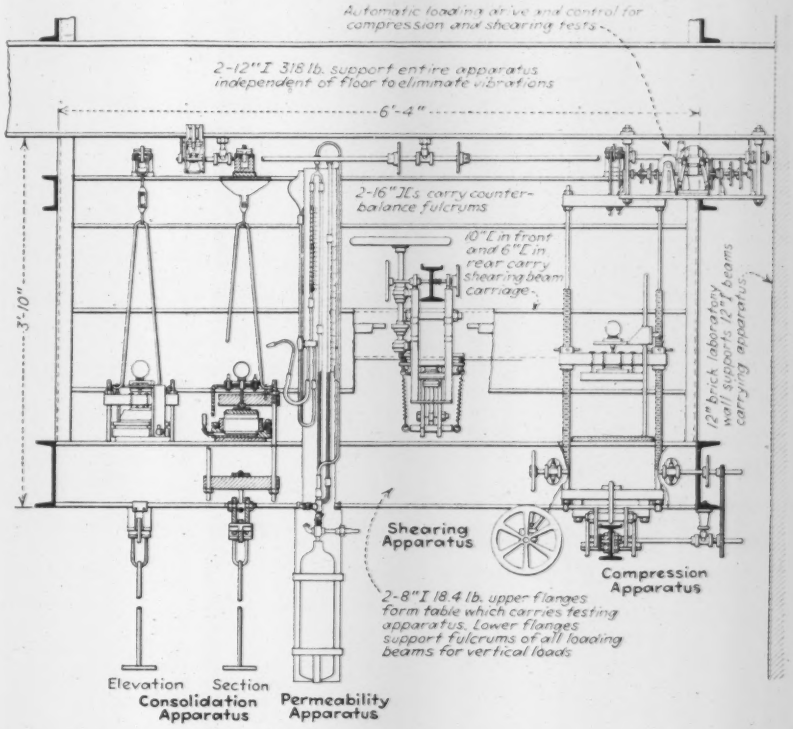

Automatic loading drive and control for compression and shearing tests
2-12"I 31.8 lb. support entire apparatus independent of floor to eliminate vibrations
6'-4"
2-16"I's carry counter-balance fulcrums
10"I in front and 6"I in rear carry shearing beam carriage
3'-10"
12" brick laboratory wall supports 12"I beams carrying apparatus
Shearing Apparatus
Compression Apparatus
2-8"I 18.4 lb. upper flanges form table which carries testing apparatus. Lower flanges support fulcrums of all loading beams for vertical loads
Elevation
Section
Consolidation Apparatus
Permeability Apparatus

FIG. 2—ELEVATION of Harvard soil-testing machine, showing four testing elements in position.

Cost of machine

The cost of the universal soil-loading machine was slightly more than $800, including labor and materials. Its successful use requires at least four consolidation devices, which can be constructed for about $80 each, and six shearing boxes, the cost of which varies between $50 and $70, depending on the type. For use with these consolidation devices and shearing boxes ten or twelve $\frac{1}{10{,}000}$-in. extensometer dials are necessary, costing about $26 each. In addition, some 1,200 lb. of lead, cast in the form of 1-, 2-, 4- and 12-kg. weights, is required for the loading apparatus at maximum capacity. The cost of these weights, including material, casting and machining to weight, is about $300. Thus the total cost of the complete testing equipment for the study of the

physical characteristics of soils is approximately $3,100. This cost, of course, does not include any changes for design or supervision.

All the apparatus described was designed by Professor Arthur Casagrande and the author. In these designs were incorporated many practical suggestions by Philip Grotjohann, in charge of the machine shop of the school, where all of the apparatus was constructed. The installation of this new laboratory was made possible by the initiative and hearty cooperation of H. E. Clifford, Dean of the Graduate School of Engineering.

This article is a condensation from an extended paper presented to the Society for the Promotion of Engineering Education at a recent meeting.

New Spillway Permits Use of Old Earth Dam

Addition of steep chute ending in a stilling pool to break the velocity allows Colorado dam to be placed in service after six years of non-use

AFTER SIX YEARS of restricted use because of the lack of a spillway, this feature has been added to the Continental earth dam on Clear Creek, Colo., 35 miles from Creede, and a state permit has been secured to make complete use of the 32,000 acre-ft. of storage that it affords. The dam was built in 1926 but, owing to the unsatisfactory design for a spillway submitted to the state engineer at that time, no spillway was included in the original construction work. Because of this omission permission was not given to fill the reservoir to a height of water beyond one-half the height of the dam, as the outlet at the flow line of the creek was not large enough to discharge the flood-waters of the watershed without overtopping the dam. The owner of the reservoir, the Order of Railway Conductors of America, Cedar Rapids, Iowa, has recently remedied this unsatisfactory situation by constructing the acceptable spillway.

The problem was solved by using a reinforced-concrete side entrance spillway at one end of the dam and a thin-section chute leading the overflow down the canyon wall to a stilling pool at the creek-bed level. Incidental problems involved making an impervious concrete and waterproofing it with asphalt to withstand the extremely low temperatures of winter at the high altitude.

The original plans contemplated the construction of the spillway along the left hand or west wall of the canyon. A forebay type of spillway was proposed which at that location would have been very expensive. Also it was considered doubtful whether a safe and permanent structure could have been built on that side of the canyon owing to a high and almost vertical wall of disintegrated rock. The right hand, or east wall of the canyon, presented difficulties also, although the wall was not nearly so high nor as steep as the left wall. It was decided to use the east side. Here all parts of the structure on the heavy slope down the canyon wall could be built on bedrock, and all of the horizontal parts could be on a compact sand and gravel formation. The wall of the canyon above the structure required some trimming, to prevent sloughing of disintegrated rock.

Three types of spillway were considered in relation to cost and safety: an over-the-top concrete chute, a siphon and a side-channel structure. From the standpoint of safe operation, considering the history of the type, the over-the-top spillway was not seriously considered. The siphon type of design was somewhat cheaper than the side-channel type but was not recommended owing to the isolated location, lack of constant supervision and the hazard of stoppage by driftwood. The side-channel type with a capacity of 1,500 sec.-ft. was adopted as being the cheapest and most satisfactory.

The transition section, 140 ft. long and

SIDE CHANNEL, chute and stilling pool of Continental earth dam. Chute down canyon wall rests on rock, while inlet and section through dam is built on a compact sand and gravel formation.

with a width varying from 10 to 20 ft., is level, to avoid the possibility of banking of the flow in the chute section, which consists of two vertical curves. The 20-ft. width at the crest narrows in the chute gradually to 12 ft. near the stilling pool. Experimental hydraulics seem to indicate that the safest procedure is not to introduce a grade in the floor of the transition section in spillways of this type.

As built, the dam is 100 ft. high and 340 ft. long over the crest. To make the spillway structure fit the topography of the canyon without excessive expense for excavation, one horizontal curve in the alignment and two vertical curves were required. The stilling pool was designed to absorb the high velocity of the water at the lower end of the chute and to deliver a much slower and uniform flow to the creek. It is hopper-shaped, 67 ft. long, 42 ft. wide and 17 ft. deep, with a weir crest cut down 5 ft.

To receive the overflow from the weir of the stilling pool and to deliver the water to the creek without danger of erosion of the creek bed or banks, a heavy apron of rock was covered with a concrete slab.

Owing to the short construction period each year at an elevation of 10,000 ft. above sea level, the work required two years to complete. Frozen ground was encountered at all times and at considerable depths. The cost of the structure, $30,000, was considered moderate in view of the fact that materials and supplies had to be hauled from Creede over mountain trail roads. Fortunately, excellent aggregates were found within a few miles of the site. A dense concrete was used to resist frost action, as the wetted parts of the structure will be subjected to long periods of very low temperature. Freezing weather during nights of the summer months and a temperature as low as 50 deg. below zero in the winter are usual. Two coats of special asphalt paint, applied hot to the wetted part of the structure, were used to protect the concrete further against frost action.

Clear Creek, on which the reservoir is located, is a tributary of the Rio Grande, and the reservoir is a part of the Del Norte Irrigation District, which supplies part of the San Luis Valley with water.

The Stearns-Roger Manufacturing Co., Denver, was the contractor. Burton Lowther, consulting engineer, Denver, designed the spillway and maintained general supervision over construction.

Trade-Waste Treatment Plant at Beltsville Research Center, Md.

Disposal plant at federal government agricultural station designed to handle large quantities of dairy and abattoir wastes—Chemical precipitation will be used as an adjunct to purification process

TRADE-WASTES treatment requirements at Beltsville Research Center, Beltsville, Md. (U. S. Department of Agriculture) are being met by sedimentation, trickling filters and separate sludge digestion, and will be supplemented by chemical precipitation using chlorinated copperas when the volume and strength of sewage increases. The plant was put in operation on July 15, 1935.

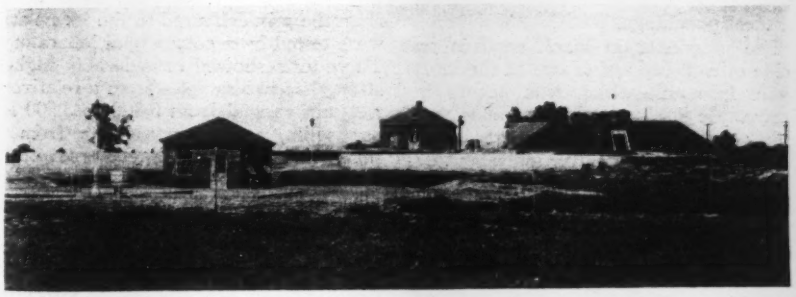
So far as has been determined, all the wastes treated will come from government property. The flow of domestic sewage will be light. Contributing trade wastes will be a 500-cow dairy, with creamery and cheese factory, a 200-hog abattoir, many barns and large laboratories. A tannery is projected.

The units of the plant, all of which except the screen are in duplicate, include a bar screen, with 1¼-in. spaces, grit chambers, Dorr flocculators, primary settling tanks, trickling filters, final settling tanks, separate sludge-digestion tanks, heated and provided with floating covers, glass-covered sludge-drying beds. Sludge gas will be used to heat the digestion tanks and the service buildings.

Supplementary equipment for chemical precipitation includes feeding apparatus for lime, copperas and chlorine.

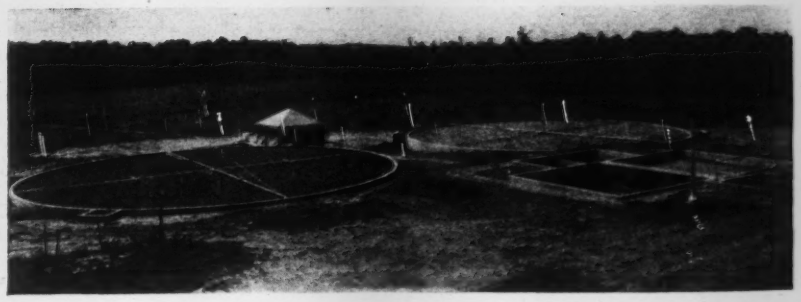
Flexibility in the application of chemicals is a feature of the plant. Chlorine can be introduced about 75 ft. ahead of the bar screen, or to either side of the plant just after the sewage leaves the grit chamber, or into the effluent from the final tanks. In the latter case the outlet sewer may be baffled to act as a contact tank. The lime, copperas and chlorine can be added to the flow just after the grit-chamber treatment and ahead of the flocculators to either of the two halves of the plant or at one point to feed both halves. Mixture of copperas solution and chlorine to form chlorinated copperas will be effected in the feed pipes through a silver tube introduced at a tee in the copperas line.

A laboratory completely equipped for



INDUSTRIAL WASTES from the Beltsville Agricultural Research Center will be treated in this compact purification plant employing plain sedimentation, augmented by chemical precipitation when so desired, trickling filters and separate sludge digestion. All the units of the plant, except coarse screens, are in duplicate.

Pacific Flush Tank Co. Photos



chemical and bacterial examinations affords a means for the control of plant operations and also for experimentation purposes.

The plant is designed for an average ultimate flow of 0.4 m.g.d., equivalent to a population of 4,000. This capacity will be materially increased when chemical precipitation is employed. Under certain conditions the load may be equivalent to that from a population of 7,000 due to the large volume and strength of the trade wastes.

Operating results

Up to Nov. 15 the load on the plant had been so low that chemicals were not needed. Many of the buildings are not yet occupied, and only half of the sewer system has been completed. Sewage flows have ranged from 0.05 to 0.2 m.g.d., against a designed capacity of 0.4 m.g.d. Removal of suspended solids and reduction of B.O.D. has been in excess of 90 per cent without chemicals. Light prechlorination is used occasionally when large quantities of blood are emptied into the system. Raw sewage ranges from very weak at night to very strong in the day (400 to 500 p.p.m. B.O.D. when hogs are slaughtered.) The B.O.D. of the effluent has never been above 30 and rarely has gone above 15 p.p.m. It is not expected that such good results will be obtained in cold weather.

The Beltsville plant was designed by Kenneth K. King, sanitary engineer, office of the secretary, U. S. Department of Agriculture, under the direction of the U. S. Public Health Service and S. H. McCrory, chief of the Bureau of Agricultural Engineering. The plant was built by W. C. Spratt, engineer and contractor, Fredericksburg, Va.

Concrete in Counterweight Made Heavy by Magnetite

Substituting a "black sand" product for ordinary sand-made concrete for lift spans of bascule bridge gives weight of 182 lb. per cubic foot—Odd properties of concrete noted

By R. B. Rothschild, Jr.
Engineer for MacDonald & Kahn Co., Ltd., San Francisco, Calif.

SPECIFICATIONS for the Park St. double-leaf bascule bridge recently built on tidal land between the cities of Oakland and Alameda, Calif., required that the counterweights consist of concrete made with steel punchings or other "approved material used as heavy-weight aggregate." Steel punchings had disadvantages that it was desirable to avoid. A substitute of superior quality was found in magnetite (the heavy black sand found in many streams and along ocean beaches) and permission was obtained to use this material in the concrete. No published data on the subject were found, and as far as could be ascertained magnetite never has been used in structural concrete prior to this work, although magnetite ore in fragments comparable to usual aggregate sizes was used as heavy aggregate in the counterweight of the Arlington Memorial Bridge. Carrying out the job, therefore, was pioneering to a certain extent. The essential features of the work and some of the odd properties of the heavy concrete are outlined in the following.

Steel punchings, which the designers originally planned to use, are difficult to obtain in large quantities and costly to clean so as to be suitable for use in concrete. Punchings might settle in one part of the forms and thereby cause unbalance in the counterweight, as contrasted to the uniformity of a concrete in which the heavy element is equally distributed. Finally, and most important, magnetite is not subject to corrosion and hence would avoid the spalling of concrete that might result if encased steel should rust. These were the considerations which led to selection and approval of magnetite as a substitute for steel punchings.

The magnetite in black sand is an oxide of iron ore and is one of the most stable forms in which iron occurs in nature. It is a very fine granular material; only a small percentage is retained on a No. 50 sieve, and about 17 per cent passes a No. 100 sieve. It can be dissolved only with difficulty, even when aqua regia is used as a solvent, and is highly magnetic, whence comes its name. When mixed with cement as a mortar it hardens into a material of extreme hardness and is highly resistant to abrasion. The specific gravity of magnetite is about 4¾, and the weight of a dry rodded sample is about 200 lb. per cu.ft.

Magnetite occurs on numerous beaches along the Pacific Coast. A conveniently accessible beach deposit near Aptos, Calif., was found suitable for this job. In the beach sand were lenses of the magnetite where ocean currents had caused concentration as the material was deposited. Selecting the more attractive of these lenses, the material was excavated by a bulldozer. A trip scraper loaded it into trucks which conveyed it to stockpiles at a near-by separation plant.

The plant consisted of an agitator-drum magnetic separator fed by belt conveyor. Material was scraped from the stockpiles to the conveyor by a horse-drawn slip scraper and was fed onto the conveyor by hand. As the material entered the separator, water was mixed with it to aid in flushing out the waste material. About 20 per cent by weight of the material entering the separator was retained in the magnetic trap.

About 400 cu.yd. of heavy concrete was required, 200 for each of the counterweights. Because of the fineness of the magnetite, which was to be used in place of sand, it was found advisable to use eight sacks of cement per cubic yard. The mix proportions per cubic yard were as follows: cement 752 lb., magnetite 2,700 lb., gravel 1,150 lb., water 48 gal. This proportioning was selected as the result of extensive tests made with sand and gravel in various combinations with magnetite. The gravel used was a composite of two sizes in equal parts; No. 1 was roofing gravel, which ranged from ⅜-in. down to ¼-in. size. No. 2 was top gravel ranging from ¼-in. down to No. 50 sieve. This mix appeared to have an even gradation of aggregate and therefore required the minimum amount of cement. A mix with finer sand was tried but was not satisfactory as it required more cement because of the greater surface area of the materials. A mix with large aggregate did not give the desired uniformity of gradation.

Advance tests made in the laboratory of the state harbor commission gave a seven-day strength of about 1,500 lb. per sq.in. and a 28-day strength exceeding 3,000 lb. per sq.in. After the job was under way, samples were taken from the mix delivered to the forms and were tested by a commercial laboratory. These tests showed considerably higher strengths; two samples from a relatively wet mix ranged from 3,300 to 3,500 lb. per sq.in., and four samples from a somewhat drier mix ranged from 4,200 to 4,800 lb. in 28 days.

Several odd features were noted in handling the magnetite concrete: There was a decided tendency to late strength. A slight excess of water in the mix was found not to have the usual effect on strength because the aggregate is so heavy that soon after pouring the excess water rises to the surface. This helped get the concrete into and around the frame of the counterweight; very little tamping was required.

Another quality worthy of note is that the surface of the magnetite concrete is very uniform and smooth, with indications of being very hard and abrasive. These qualities would suggest that magnetite might be of considerable advantage when making a concrete surfacing on warehouse floors, pavements subject

to much wear or other surfaces where heavy abrasion is expected.

The Park St. Bridge was designed under the direction of Burnett Hamilton, county surveyor, and Bruce Jameyson, bridge engineer, Alameda County, Calif. Contract for erection was carried out by McDonald & Kahn Co., Ltd., under the supervision of B. F. Modglin, vice-president and general manager. D. Young was superintendent. The magnetite concrete was developed by the writer. A. A. M. Russell, testing engineer, Board of State Harbor Commissioners, conducted the tests and designed the mix.

Letters to the Editor

Further Factors in Structural Analysis

Sir—Professor Cross is to be congratulated on his article on the "Limitations and Application of Structural Analysis," (*ENR*, Oct. 17, 1935, p. 535, and Oct. 24, p. 571). His emphasis on the physical properties of the material is timely and well placed. I feel sure that every practicing engineer who is doing any real thinking about these things will agree with what he has written.

There are perhaps two additional features that enter into structural design and analysis. These are:

a. The necessity of taking into account the often wide departure from theory dependent on a different stress distribution from that on which the theory is based.

b. The recognition of two distinct classes of loads: gravity loads and elastic-reaction loads.

A familiar example of the first of these—the stress concentration due to shape, especially under circumstances where conditions capable of producing fatigue failure are present—is perhaps the most common. In relation to this the application of St. Venant's principle is of considerable importance.

As an example of the second, the loads acting on a masonry dam form a simple case. The water pressure is a gravity-type load, and it is independdent of the mechanical (elastic) properties of the structure. Ice pressure, however, belongs to the elastic-reaction class, for the load can be applied only in so far as it has something to push against. Under such conditions a flexible structure will be found to be more economical than a more or less rigid mass. Structural analysis should take acount of such loads. They often go unrecognized.

I. F. MORRISON,
Professor of Applied Mechanics,
University of Alberta.
Edmonton, Alberta,
Nov. 2, 1935.

Properties of Foreign and Domestic Steels

Sir—I recently had occasion to tabulate the physical and chemical properties of various foreign and domestic steels. The accompanying tabulation proved to be of interest to me, and they may also have some value for the readers of *Engineering News-Record*.

JOSEPH G. SHRYOCK,
Chief Engineer,
Belmont Iron Works.
Philadelphia, Pa.
Oct. 30, 1935.

PHYSICAL AND CHEMICAL PROPERTIES OF FOREIGN AND DOMESTIC STEELS

Process	Nation / Kind	No. / Grade	Physical Properties: Min. Yield	Tensile St.	Elong. 8-in. *	Chemical Analysis: C.	P.	Su.	Mn.	Si.	Cr.	Ni.	Cu.
O.H.	American (Bridge)	A7–34 Cu. B	33,000	60–72,000	1,500,000 / Ts. Stg.	0.10	0.04	0.05	0.50	0.10	.....	.....	0.20
O.H.	American (Silicon)	A94–33	45,000	80–95,000	16%	0.40	0.04	0.05	1.00	0.20	.....	.....	.....
O.H.	American (Nickel)	A8–29	50,000	85–100,000	15%	0.25	0.04	0.05	0.70	0.12	.....	3.00	.....
O.H.	American (Mayari-R)	Beth. Steel	50,000	85–100,000	1,600,000 / T. S.	0.35	0.03	0.04	0.80	0.15	0.36 / 0.47	1.27 / 1.51	0.45
*O.H.	American (Cor-Ten)	U. S. Steel	50,000	70,000 Min.	27% = 2"	0.10	0.10 / 0.20	0.05	0.10 / 0.30	0.50 / 1.00	0.50 / 1.50	.....	0.30 / 0.50
O.H.	American (Man-Ten)	U. S. Steel	55,000	85,000 Min.	23% = 2"	0.35	0.04	0.05	1.25 / 1.70	0.15 Min.	.....	.....	0.20
O.H.	American (Sil-Ten)	U. S. Steel	45,000	80–95,000	18% = 2"	0.40	0.04	0.05	0.70 / 0.90	0.20 / 0.30	.....	.....	.....
O.H.	British (Bridge)	15-A	31,000	63–74,000	20%	0.18	0.06	0.06	.....	.....	.....	.....	.....
*O.H.	British (Cromador)	Dorman Long	52,000	83–96,000	17%	0.22	0.05	0.06	0.80	0.20 Max.	0.90	.....	0.30
O.H.	American (Double Strength)	Rep. Steel	60,000	75,000 Min.	25% = 2"	0.12	0.04	0.05	0.50 / 1.00	0.10	.....	0.40 / 0.80	0.50 / 1.50
B.B.	German (St. Ry.)	St. 48	41,000	68–82,000	18%	0.25 / 0.35	0.07	0.06	0.50 / 0.70	0.15 / 0.30	.....	.....	.....
*B.B.	German (St. Ry.)	St. 52	51,000	74–88,000	20%	0.12 / 0.15	0.07	0.06	0.75 / 0.90	0.80 / 1.10	.....	.....	0.25 / 0.40
*B.B.	German (Bridge)	Krupp	51,000	77–91,000	20%	0.12 / 0.15	0.07	0.06	1.20 / 1.60	0.30 / 0.60	.....	.....	0.30 / 0.60
B.B.	French (St. Ry.)	Ac. 42	34,000	60,000 Min.	25% Min.	.....	0.07	0.06	.....	.....	.....	.....	.....
*B.B.	French (Bridge)	Ac. 54	51,000	77–91,000	20%	0.15	0.07	0.06	0.90	0.17	0.40 / 0.60	.....	0.30 / 0.60
O.H.	American (Cromansil)	E.M.C.	50,000	85–90,000	20%	0.20	0.04	0.05	1.10 / 1.40	0.60 / 0.90	0.40 / 0.60	.....	.....

*(Also 0.20 per cent molybdenum)

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December 5, 1935

City of New York—Landlord

DEDICATION of a municipal housing project in New York City this week is a significant event. It marks the advent of municipally owned and operated housing in the United States, of which more will be heard in the years immediately ahead. European countries that have embraced such housing for their low-income workers report marked success with it, and on this score it has been urged upon American cities. Whether it will take or not under the different conditions existing here remains to be seen, but there is little doubt that other cities will try it. Most of the states have laws permitting municipal housing authorities to function, and a number of cities have appointed such bodies. The PWA program of fifty housing projects in some thirty-five cities has absorbed or delayed most of the municipal housing plans, but the attention focused on slum clearance and large-scale housing during the depression assures that the municipal housing idea will not be dropped without a trial. New York's first attempt under Langdon W. Post, tenement house commissioner, embodies the remodeling of some old walk-up buildings on the lower East Side, bringing them up to modern standards and separating them by gardens and playgrounds. They will accommodate 120 families, who have been carefully chosen on the basis of low income and rehousing need. The difficult and decisive phase of the experiment—that of management—is about to begin. If this works out successfully, low-rent housing may be launched as a public utility to take its place beside water supply and sewerage. At any rate, the possibility of such a development is strong enough so that city engineers have a responsibility to keep posted on municipal housing trends.

Pioneer Highways

CANADA has used the needs growing out of the depression to push construction of its long-projected Trans-Canada Highway through many miles of the wildernesses of northern Ontario and far up into the Rocky Mountains. Few people in this country realize that there are no roads in Canada connecting the populous regions lying east of Lake Huron and Lake Superior with the Prairie Provinces to the west. The cities on the Pacific Coast are similarily isolated except for rail connections. During the past few years employment for many men has been provided in the work of closing these gaps. There remains a little over 50 miles in the Rocky Mountains and about 200 miles in northern Ontario, as outlined in this issue. In its usefulness and morale-maintaining qualities, the work is comparable to that of the Civilian Conservation Corps in this country. The men are housed in rough but reasonably comfortable camps and are employed in work that obviously is useful, which is important in maintaining their self-respect. Though it is quite apparent that all the unemployed cannot be cared for in this manner, these undertakings do show that the wastefulness of many of our efforts to relieve unemployment could be avoided were the proper federal, state and municipal officials given more opportunity for advance planning and definite programming of operations to be carried out under their direction.

From Tools to Machines

THE MACHINE for making simultaneous tests of several soil samples which is described in this issue marks a concluding step in developing aids for the soils laboratory worker. It represents the progress in invention from single tools to machines that perform group operations. The advance has not been an easy one, and that it has been so rapid is a credit to the soils physicist, whose systematic study of the reactions of soil to stress began scarcely fifteen years ago. At the beginning only the apparatus that he could produce with his hands was at the command of the student; belief in the value of his work was slow in reaching the certainty that encouraged financial support, and few except himself knew enough about the new science to give competent advice. The laboratory worker became of necessity a toolmaker, and he produced a tool at a time as the need developed. The following step taken by the Harvard soil physicists has been to produce a machine to do the work simultaneously of several tools, and so reduce labor and increase output. It is an application in the testing laboratory of the inventive processes responsible for mass production in the factory, and is the more timely because in the work of the engineer today every additional item of substantiated information on the behavior of soils under load is needed for practical information.

Protection by Firestops

A DOZEN YEARS AGO an epidemic of destructive fires in wooden bridge floors focused attention on a danger until then unrecognized. In bridge after bridge a fire that started in the floor planking swept along the structure so quickly and developed so much heat that fire fighting was out of the question, and usually the whole structure was wrecked. While increased bridge use was readily recognized as the cause of the fires, the reason for their destructive character was obscure. At the suggestion of *Engineering News-Record*, therefore, the matter was investigated by an engineering committee that included fire underwriters, highway engineers, wood-preserving men and others. It turned out that creosoted timber, contrary to what had been suspected, was no more flammable than untreated wood, and that the severity of the fires was chargeable to neglect of proper precautions to check the spread of fire under the horizontal chimney effect under the floor. Chief of the recommendations (*ENR*, Nov. 9, 1922, p. 797), was that firestop diaphragms should be constructed at frequent intervals under the bridge floor, to break up the flue action. Many bridges have since been built with such firestops, and they have been uniformly successful until the recent fire described in this issue by S. B. Slack. From the details of the case it appears that the firestops were spaced too far apart, and it is also probable that their construction allowed fire to leak through along the under side of the floor. The fire, therefore, does not argue that proper firestops are ineffective. On the contrary, the record of the years since firestops were introduced affords strong proof of their value. They must be properly built, of course; so built they are effective as first line of defense against fire destruction of bridge floors. The present fire serves as a challenge to the

builders of wood floors to develop a second line of defense against the spread of fire along the deck.

Noteworthy Invention

AN EXCELLENT EXPRESSION of ingenuity as a vital element of engineering is presented by the pavement-moving operation described in this issue. The problem was unique; frequency of accidents made it necessary to convert a four-lane three-slab pavement into a dual pavement with opposing streams of traffic separated by an island. If the old pavement could be split and one part moved laterally by the width of the proposed island, the new construction of a 10-ft. widening would provide dual 25-ft. pavements. To make this possible required some real inventiveness. No precedent was available, and ordinary means of applying a moving force were unfitted to start movement from the narrow separating cut made possible by removing the filler in a longitudinal joint. The ingenious idea was conceived that if a hose could be pressed into the open joint and inflated, the joint could be opened sufficiently to provide a purchase for jacks; the following thought was that if inflation of a hose would start movement, it could be made continuous by blocking behind to provide a constantly narrow joint. The intricate problem of devising the mechanical procedure is indicated by the illustration of details on preceding pages; but the broadly significant lesson lies in the simplicity of the means used, in contrast with the magnitude of the resistances. This simplicity bears the distinctive stamp of engineering invention. In further appreciation of this technical skill it deserves mention that no detail of equipment or procedure required substantial change since it was put to the test of actual operation in the field.

A Tunnel is Completed

THE FINAL CHAPTER of the spectacular history of construction of the Moffat Tunnel is being written with the replacement of more than three miles of timbering by concrete in most ingenious manner during lulls in traffic. Ranking second in length only to the Great Northern's Cascade Tunnel, the Moffat bore has been one of the most interesting, difficult and expensive railroad tunnels in the country.

From the time that David Moffat was thwarted in his courageous attempt to build a direct Denver-Salt Lake line across the backbone of the Rockies in Colorado the Moffat Tunnel project has been in difficulties. Lack of finances prevented Moffat from driving the tunnel as he built the line, and later resulted in halting the advance of the new road when steel was only halfway toward its intended destination. Colorado through a tax district finally built the tunnel, but only after disheartening construction difficulties had raised the cost to three times the original estimate of $6,000,000. The 50-year lease to the Moffat railroad, based on amortization of only half the cost of the project, left bondholders and taxpayers to carry a heavy financial burden. But eventually Moffat's dream of the short route across the mountains came true: the Dotsero cutoff was built.

Soon after the tunnel was placed in operation maintenance of the timbered sections became troublesome and expensive. The timbers were alternately soaked by ground seepage and dried out by hot locomotive gases swept through the long bore by powerful ventilation fans, and deteriorated so fast that after five years of constant timber replacement the railroad concluded the only solution to the expensive maintenance problem to be replacement of all timber by concrete lining.

The concrete lining work marks the completion at last of the bold project conceived in David Moffat's mind a half century ago. It is the end of a most remarkable story of railroad tunnel driving.

With Benefit of Experience

FOR nearly a year it has been known that federal relief contributions could not long continue, and that they would end as soon as the works program was in action. The President announced this purpose last January, and the universal approval with which his statement was greeted left no doubt that it would be carried into effect. Termination of relief contributions on Dec. 1 is, therefore, no unexpected event. Circumstances make it significant, however, by placing the decision on most effective procedure in local hands.

State and city authorities in taking over the primary responsibility for relief activities are in a position to adopt the methods of soundest character, largest permanent value and least cost. Since the experience obtained through the federal government's relief and works undertakings is available to them, they have no need to experiment. The results of the PWA methods and those of the quondam Civil Works Administration and the present Works Progress Administration are familiar to all. We have had large-scale demonstrations of the relative value of productive reemployment carried on under normal conditions, and extemporized employment of little production value carried on under decidedly abnormal procedure.

It is known that the former costs more for the time being, but that on the other hand it is self-limiting, because it aids the revival of industrial and business employment. It is no less well known that extemporized work methods, despite their lower man-day cost, mean much larger expenditure in the end, since they retard normal reemployment by conflicting with the operations of existing businesses. Further, the radical difference between the two in their effect on initiative, on self-respect, and on all the elements that build up a sound social structure, is recognized by all.

With local treasuries amply stocked, the choice could not be in doubt, in view of the convincing demonstration supplied by the federal operations. But city and state finances at present are in so difficult a situation that arguments of momentary economy may prevail unless right thinking takes command from the start. The question at issue concerns engineers both as citizens and as professional men who know construction. They can perform a public service by helping to bring about sound procedure.

Experience has demonstrated that leafraking and welfare-work employment attempts cannot meet the test, whether judged by cost standards or by overall effect on the well-being of the community. The new relief burden may soon become intolerable if such methods are chosen in preference to constructive work. We need administrative policy that at all points supports the resumption of normal business relations both within and without the government.

CURRENT NEWS

President Approves Funds For Natchez Trace Highway

An allotment of $1,350,000 for the Natchez Trace Highway project, together with a $150,000 survey project along the route has been approved by President Roosevelt. Although both projects are yet to be approved by Comptroller-General McCarl and funds are yet to be allotted by the Mississippi state WPA, the state senate has already approved measures designed to speed reconstruction of the historic old Indian trail into a scenic highway from Nashville, Tenn., to Natchez, Miss. The highway would form a link between the east and the Mexican border. First money would be spent on about 40 mi. of the highway between Natchez and Tupelo, Miss.

The state senate has authorized the state highway department and the county boards of supervisors to acquire and deed to the U. S. National Park Service a right-of-way for construction of the Natchez Trace. The bills give the state and county road authorities the right to confiscate property for the new highway, with the state to bear one-half and the counties one-half of the right-of-way costs. The federal government will pay the cost of construction.

With an appropriation of $50,000 by Congress in May, 1934, the Park Service and the Bureau of Public Roads located the old trace and established a proposed alignment for the parkway. Sufficient topography and preliminary design was to have been completed by Dec. 1 to enable the federal agencies to undertake actual construction within a month after work relief funds become available.

Complete survey planned

The Park Service desires, however, to first make a survey between Jackson and Natchez, Miss. (unit 1) and Tupelo and Jackson (unit 2), and preferably of the entire route, comprising five units, to Nashville, Tenn. Construction cost of the Natchez-Jackson unit is estimated at $5,000,000 and the Jackson-Tupelo unit at $10,000,000. The Natchez-Jackson unit marks the historically significant section of the route and would also furnish a needed connecting highway, but it is probable that the $1,350,000 allotment for construction will be divided equally between the two units.

As in national park areas, the project is being carried on jointly by the Park Service and Bureau of Public Roads under an interdepartmental agreement that has been in effect for several years. Such parkway construction is a comparatively recent development, best exemplified to date by the Skyline Drive in the Shenandoah National Park (*ENR*, July 25, 1935, p. 112). Plans for the Natchez Trace parkway contemplate grade separation at intersections with important highways and acquisitions of broad rights-of-way, which are to be donated by the counties and states through which the parkway will run, in order to control commercial enterprise and in this way preserve the natural beauty along the scenic route.

Federal Funds For Direct Relief Ended, Works Program To Be Continued

(Washington Correspondence)

THIS WEEK the federal government squirmed out from under the burden of direct relief that in three years has cost it more than $3,000,000,000. A bar to ever balancing the budget if continued, the distribution of cash relief grants to all states was stopped Dec. 1 when employment on the relief works program officially reached the goal of 3,500,000 persons.

The Federal Emergency Relief Administration is disbanding as the states and communities are forced to pick up the burden of caring for unemployables and it will only be in dire extremity that the federal government will permit itself to be drawn back into the direct relief business.

This isn't the social arithmetic which everybody has been accustomed to regard as characterizing the New Deal. Ending the dole at this time coincides with the period of heaviest load, but protests by Gov. Hoffman, New Jersey, Gov. Davey, Ohio, and by other states have been futile.

Works program to be continued

Supporting employables on relief rolls remains the responsibility of the federal government until such time as they are absorbed by private industry. As industry likewise has to absorb an equal if not larger number of employables not on relief rolls, the continuation of some sort of works program for an indefinite time to come is a foregone conclusion.

WPA will carry on until July 1, 1936, and beyond, although at present the form of the next works program and its cost are only conjecture. Hearings on the next fiscal year's appropriations for the ordinary budget opened this week and will be held down to about $5,000,000,000, according to Chairman Buchanan, of the House Appropriations Committee. He regards an additional $1,000,000,000 as the limit for the next work relief program and is hopeful that only half of last April's $4,880,000,000 appropriation will have to be spent in the present fiscal year.

The states should be required, in Rep. Buchanan's opinion, to care for all unemployed when the number declines to 3,000,000 but he favors preparation of a permanent public works program to be brought into action whenever the volume of unemployment rises above this figure. Congress is expected to prefer a larger proportion of public works to relief work projects in the next program. A return to the customary practice of appropriating for specific projects is seen with respect to federal works.

Type of PWA projects uncertain

Continuation of federal grants and loans for non-federal projects of the character included in the current PWA program is uncertain. Administrator Ickes does not favor indefinite perpetuation of this form of federal assistance but is prepared to undertake next year as big a program as the President and Congress will finance. Applications on file with PWA for projects that have been approved on preliminary examination total $500,000,000. All told there is $1,000,000,000 in applications on the suspense docket. There are about 7,000 projects, of which 5,000 would be eligible for consideration in the event that more funds are made available.

The WPA program that, according to official advices at least, now is in full swing, presents sharply contrasting conditions from state to state. Most projects now in the work stage are those that could be undertaken quickly in an effort to make up for lost time and reach maximum employment without further delay. The first wave will be followed by another comprising larger, more pretentious projects that get under way more slowly. Completion of the average project is estimated at three months. This is based on a labor efficiency rating of 65 per cent, but WPA officials are gratified by job experience indicating that workers are 85 per cent efficient.

In the drive to create employment, the relief works program is actually running into a deficit. Even with 3,500,000 persons at work, this total is 21,000 less than the number employed on government work programs one year ago.

Continuation of Control Surveys By State WPA Authorized

WPA has approved as eligible for work relief funds, the continuation of supplemental geodetic control surveys in states which elect to do so. This supplemental control program was initiated by the Coast & Geodetic Survey in the fall of 1933 to provide employment for engineers and other college-trained men. Such employment reached a maximum of 10,000 but the program was terminated as a federal project in February, 1934, when Congress held that the emergency relief appropriation made at that time could not be spent on federal projects. It was continued to a greater or less extent, however, in 23 states as a part of their emergency work programs and now becomes an eligible project under the WPA program.

How many states will take advantage of WPA funds to resume such work and how much money will be made available is not known as the project is to be carried out entirely under state direction, the Coast & Geodetic Survey serving only in an advisory capacity. The Survey has not been able to obtain any work relief funds whatever, either for the conduct of basic surveys or for processing field data previously accumulated. Its projected program has been submitted in several alternative forms but has not been approved.

Georgia Resettlement Project Inspected by President

President Roosevelt, on Dec. 2, visited one of the country's first resettlement projects in Pine Mountain Valley, Ga., which at present consists of over 70 families and which will eventually sustain from 250 to 300 families.

The project, which was authorized about two years ago, covers about 10,000 acres, including some excellent farm land. The work, which was begun before the inception of the Rural Resettlement Administration, is being carried out with funds allotted by the Federal Emergency Relief Administration to the Georgia Rehabilitation Corporation. So far a sum of $500,000 has been spent on the project and plans call for the use of $650,000 more. The cost of the project is charged against the resettled families in the form of long-term loans.

Work was begun in a section covered with second-growth pine in an area where the land was being rapidly eroded. The government provided the settlers with modern farming implements and stationed a CCC company to clear the land and terrace the slopes in order to check erosion. The community has small cottages situated on a 13-acre plot of ground and each house has electric power. A water tower has been erected to provide the community with water and a community center has been built. Future plans call for the erection of a school, a canning and preserving factory and a warehouse.

In a short talk the President pointed out that this was more or less of an experimental project as it would be impossible for the government to take care of the 1,000,000 families that would need this sort of help. He also pointed out that through settlements of this kind that natural timber resources could be preserved and increased.

Plans for Cincinnati project

A detailed plan of the federal resettlement project for Cincinnati, Ohio, was announced this week by Albert L. Miller, senior administration officer recently appointed for the project by the Resettlement Administration.

The plan involves the use of 5,000 acres of land, selected from a block of 12,000 acres now under option, near Mt. Healthy, a Cincinnati suburb. The project calls for erection of 1,500 dwellings in the form of a model town, with group houses, business center, schools, churches, police and fire centers. The Cincinnati area was selected because of its growing industries.

Increased Diversion of Water From St. Lawrence Approved

The Beauharnois Light, Heat and Power Co. has been granted permission by the Canadian Government to divert water amounting up to 53,072 sec.-ft. from the flow of the St. Lawrence River for power development purposes, this being an increase over the previous authorized maximum of 35,000 sec.-ft. The Order in Council authorizing this increase was passed after governmental engineers had inspected and approved the regulating works which the company has now built at the foot of Lake St. Francis, and in the river immediately below, safeguarding navigation requirements.

NEW YORK CITY POST OFFICE ANNEX

The New York City Post Office Annex, built at a cost of about $10,000,000 has some of the largest girders ever used in New York City buildings. Forty-one girders of greater than sixty tons weight and from 75 to 116 ft. long were used to span the electrified tracks of the Pennsylvania Railroad. The longest girder which was 116 ft. long and 9 ft. deep weighed 133 tons. In order not to disrupt the train service, steel erection was possible only for brief periods after midnight.

The new annex, which is 419 ft. x 454 ft., is located on the east side of 9th Ave. between 31st and 33rd Sts. and adjoins the general post office which faces on 8th Ave. The annex has five stories and a basement and has highly mechanized mail handling facilities.

James Stewart & Co., Inc., did the general contracting and McClintic-Marshall Corp. did the steel fabrication and erection. A. L. Selio was general superintendent for James Stewart & Co., Inc.; E. F. O'Brien, construction engineer for the Treasury Department; George C. Lane, engineer of erection for McClintic-Marshall Corp. McKim, Meade & White were designing architects of the post office addition with Gibbs and Hill as consulting engineers.

Consolidated Mapping Agency Proposed by Science Board

Consolidation of all major federal surveying and mapping agencies into one central bureau under the name of United States Coast and Interior Survey is recommended in the report recently submitted to President Roosevelt by the Science Advisory Board, headed by Dr. Karl T. Compton. The new bureau would be set up either as an independent agency or as a unit of the Department of the Interior. In its initial form it would take over the work and personnel of the present Coast and Geodetic Survey, the Lake Survey, the International Boundary Commission, the Topographic Branch of the Geological Survey, and its Division of Engraving and Printing. Continuation of the present Federal Board of Surveys and Maps in an independant advisory capacity is also recommended.

In its survey of the existing situation the board discovered that 28 separate government bureaus and agencies now work independently in making and using maps, resulting in loss of efficiency, duplication of effort, and the employment of inadequate personnel in many cases. While a number of these perform highly specialized work and would therefore be omitted from the consolidation, it is felt that the efficiency and economy inherent in the proposed plan would eventually lead to its taking over more and more of the federal mapping. It is recommended, however, that the new department start with a small nucleus in order to minimize interruptions and dislocations of the work.

The board also stressed the importance of providing as soon as possible a standard topographic map covering the entire country, pointing out that the cost of such an undertaking would be fully justified by its usefulness in engineering planning.

Changes in PWA Allotment Allows Revised Tunnel Plans

A change in the PWA allotment to the Port of New York Authority for construction of the Midtown Tunnel which will enable the authority to revise its plans so as to provide better facilities for handling traffic on the New Jersey side of the Hudson River was made on Nov. 26.

The revised allotment converts the original loan of $37,500,000, without grant, to a grant of $4,780,000 without loan. This change, requested by the Port Authority, will enable it to construct a connection between the tunnel entrance and principal traffic arteries, and to utilize private capital in accordance with PWA policy. The change also releases PWA from its contractual obligations to purchase $15,200,000 worth of Port Authority bonds and makes the money available for loans on new public works projects. Administrator Ickes had previously indicated that this money might be applied to the 38th St. East River tunnel but he stated on Nov. 26 that this would not be enough.

Including the traffic connection to be built under the revised allotment, the Midtown Tunnel will cost $42,000,000. PWA originally allotted $37,500,000 to the Port Authority as a loan, without grant, for the tunnel. The Authority did not request a grant in its original application, although it was eligible, as a public body, to receive a grant.

The Port Authority sold in the private investment market $22,300,000 worth of the bonds PWA agreed to purchase under the $37,500,000 loan allotment. It then proposed cancellation of the contract under which PWA was obligated to purchase the remaining $15,200,000 worth of bonds, in consideration of PWA making a grant of 30 per cent of the cost of the work remaining to be done.

PWA Issues Rules Governing Use Of Foreign Materials

PROTESTS against the use of German steel on PWA projects having been stilled by raising the differential in favor of domestic materials from 15 per cent to 25 per cent, Administrator Ickes is investigating complaints concerning the use of asphalt manufactured from imported crude petroleum. Ickes said that a letter from Senator Sheppard, of Texas, had been referred for investigation, and that the facts revealed will be referred to the Bureau of Public Roads. That agency will do, he said, what seems proper under the circumstances. As in the controversy concerning German steel, Ickes said that PWA has no jurisdiction, inasmuch as road contracts let by the states are "out of our hands."

Prima facie evidence of collusive bidding by domestic steel companies on a graving dock at Miami, Fla., as well as the New York Triborough Bridge and the Morehead City, N. C., port terminal has been submitted to President Roosevelt, said Mr. Ickes, This has been referred by the President to the Federal Trade Commission for investigation.

PWA has issued a revised order governing purchase of materials. This establishes a differential of 100 per cent in favor of domestic materials when foreign materials are offered at $100 or less and of 25 per cent when foreign materials are offered at a price in excess of $100 and provides that, in any case, no foreign materials shall be purchased without the consent of Administrator Ickes. The revised order also states that domestic materials are defined as only unmanufactured articles, materials, and supplies mined or produced in the U. S., and manufactured articles, materials, and supplies manufactured in the U. S., substantially all from articles, materials, or supplies mined, produced, or manufactured, as the case may be, in the U. S.

TVA to Build a New Dam Nine Miles Below Guntersville

Construction of an additional dam on the Tennessee River 9 miles below Guntersville, Ala., at Cole's Bar Bend, has been authorized by the Tennessee Valley Authority as part of its long-time program for the development of the river. The new structure will cost approximately $29,000,000 and will be located at the head of the reservoir created by Wheeler Dam. It will consist of two earth-fill sections on either side of the river with lengths of 1,000 and 1,300 ft.; a concrete spillway section 1,240 ft. long with a maximum height of 80 ft.; 340 ft. of power house foundations, and a lock with a single lift of 40 ft. The latter, as on all TVA dams, will be designed by the Corps of Engineers. The dam will store 240,000 acre-ft. of water. No initial power plant installation is contemplated.

At the last session of Congress the House appropriated $34,675,192 to be used by the TVA for the construction of the Guntersville Dam and Chickamauga Dam. Preliminary studies for the latter are well along.

Little Rock Offers to Buy Water Company Properties

The city of Little Rock, Ark., has made a formal offer of $3,000,000 for the properties of the Arkansaw Water Co. in that city. The city has asked that the company accept or reject the offer within ten days from Dec. 2.

Decision to make the offer was reached after the PWA legal division told city officials that the city must acquire the distributing system of the water company without delay, if it wished to qualify for a loan of $1,694,000 and a grant of $1,386,000, already allotted by the President. It was indicated that the PWA would be willing to accept a legal option or certified purchase agreement between the city and the water company for release of the grant.

It is reported that private financing can be arranged for purchase of the water company's properties, but it is planned to ask the PWA if 15 per cent of any agreed purchase price might be given to the city as an outright grant.

There are three courses open by which the city might proceed. They are an agreement between the city and the company for immediate purchase of the latter's property; an appeal to the state Department of Public Utilities to fix a fair value for the property; or a special election to authorize condemnation proceedings in the courts.

When the city has committed itself to purchase the property, PWA will be asked to outline other requirements that must be met to obtain the $3,080,000 allotment approved by President Roosevelt for construction of a water reservoir and pipeline. Acquisition of the distributing system would remove a major objection of the PWA, which has taken the position that the company, if permitted to distribute water from the new source of supply, would receive the chief benefit from the loan and grant, which is contrary to the PWA policy.

Steel Sheetpile Cutoff Wall At Fort Peck Dam Is Completed

The last steel sheetpile in the 10,146-ft. cutoff wall under the base of Fort Peck Dam was driven by the graveyard shift Nov. 25, completing the greatest project of its kind in engineering history. Final closure of the long steel wall was made on the steep west bank of the river valley where a few days previously steel sheets had been driven to a record depth of 163 ft. The Frazier-Davis Constr. Co. and G. L. Tarlton, of St. Louis, Mo., were contractors on the wall, starting work by driving the first pile on Aug. 30, 1934. Four 200-ft. traveling tower gantries were used in driving the sheeting, and long-boom cranes assisted in handling the long sheets and the jets. Two ingenious types of hydraulic spade jets, designed by the contractor and operating under water pressure of 200 lb. per sq.in., made the deep driving possible (see *ENR*, Jan. 10, 1935, p. 35, and Aug. 29, 1935, p. 291). In the two-mile length of steel wall are 17,390 tons of sheet piling aggregating 214 miles in length. Transportation of steel required 425 freight cars. In excavating the trench to receive the piling the contractor moved 75,000 cu.yd. of material.

Buffalo Sewer Bids Asked, PWA Engineer Approval Pending

BIDS for the construction of about [illegible] ft. of 27-in. connecting sewer, part of the Bird Ave. section of the new sewer system of Buffalo, N. Y., have been authorized by Harold Epstein, PWA engineer, in order to meet the President's deadline of Dec. 15 for having projects under way, in the event that Administrator Ickes approves the selection of Greeley & Hansen, who on Nov. 26 were awarded the engineering contract on a bid of about $378,000 by a three to two vote of the Buffalo Sewer Authority. This work forms only a small part of the $15,000,000 project and will cost between $35,000 and $40,000 but is held sufficient to bring the entire project within the meaning of the President's order. All bids would be cancelled in the event of the disapproval by Administrator Ickes of Greeley & Hansen as engineers.

The contract of the Buffalo Sewer Authority with Greeley & Hansen now is being considered by Administrator Ickes. The two adverse votes against it were cast by Chairman Daniel H. McCarriagher and Henry W. Keitzel because of the cancellation clause. Efforts are being made to compromise this clause by changing it so that the engineers cannot be dismissed without the approval of the PWA.

Criticism of the manner in which the contract was handled continues to keep the matter stirred up in political as well as engineering circles.

Court Refuses Injunction In Airport Lighting Case

The Superior Court at Providence, R. I., ruled, Nov. 22, in favor of the New England Machine and Electric Co., Pawtucket, which was recently awarded a $39,000 electrical contract at the Warwick, R. I., airport (*ENR*, Nov. 14, 1935, p. 659). Coken & Co., Providence, plaintiff, sought an injunction to prevent completion of the contract on the grounds that their bid submitted for the contract was lower.

The court ruled that the State Public Works Emergency Relief Commission had properly guarded the contract after receiving Mr. Hoffman's approval, and that court had no power to review the acts of an administrative body acting within its discretion under a valid statute. It was further ruled that though the government by suspending Mr. Hoffman has implied that the contract was improperly awarded, he was the federal official designated to approve bids and when the state commission received that approval it had pertinent evidence on which to proceed with the work.

Specific charges of violation of PWA rules against Leslie A. Hoffman, PWA engineer for Rhode Island and Connecticut, Frank B. Perry and William Albrecht, examining engineers at Providence, R. I., were received Nov. 20. Suspension of the three engineers resulted when Coken & Co. filed suit because the New England Machine & Electric Co. was awarded a contract for electrical work at the airport on its bid of $39,250 which was higher than the Coken company's bid of $33,609.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual convention, Miami, Fla., December 9-12.

AMERICAN SOCIETY OF PLANNING OFFICIALS, state planning conference, Chicago, Ill., December 12-13.

NATIONAL RIVERS & HARBORS CONGRESS, special meeting, New Orleans, La., December 13-14.

NATIONAL ASSOCIATION OF HOUSING OFFICIALS, annual meeting, New York, December 14.

AMERICAN ENGINEERING COUNCIL, annual meeting and conference of Secretaries of Engineering Societies, Washington, D. C., January 9-11, 1936.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual meeting, Miami, Fla., January 13-15, 1936.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York City, January 15-18, 1936.

AMERICAN ROAD BUILDERS' ASSOCIATION, annual convention and road show, Cleveland, Ohio, January 20-24, 1936.

CONSTRUCTION EQUIPMENT ASSOCIATION, first annual meeting, Cleveland, Ohio, January 20-24, 1936.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Columbus, Ohio, January 29-31, 1936.

AMERICAN SOCIETY FOR TESTING MATERIALS, regional meeting, Pittsburgh, Pa., March 4, 1936.

AMERICAN WATER WORKS ASSOCIATION, annual convention, Los Angeles, Calif., June 8-12, 1936.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting, Atlantic City, N. J., June 29-July 3, 1936.

WASHINGTON IRRIGATION INSTITUTE, annual meeting, Wenatchee, Wash., December 12-13.

NEW YORK BUILDING CONGRESS, luncheon meeting; Eugene Meyer, guest speaker, New York City, December 18.

METROPOLITAN SECTION, American Society of Civil Engineers, New York City, December 18.

NEW YORK SECTION, AMERICAN WATER WORKS ASSOCIATION, midwinter meeting, New York City, December 27.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, annual meeting, Atlantic City, N. J., February 12-14, 1936.

SOUTHWEST ROAD SHOW AND SCHOOL, Wichita, Kan., February 25-28, 1936.

EXAMINATIONS for registration of professional engineers will be held in the near future, as follows:

MICHIGAN—Examinations for registration of Architects, Engineers, and Land Surveyors by the Michigan State Board of Examiners for the Registration of Architects, Engineers and Surveyors will be held December 26-28, 1935. Examinations for architects at the University of Michigan; for engineers and surveyors at University of Michigan, Michigan State College and Ironwood.

Power Commission Gets Funds To Continue Studies

An additional allotment of $250,000 to the Federal Power Commission to continue investigations and studies authorized by executive order and in accordance with a Senate joint resolution has been made from old PWA funds.

Of the amount allotted, $150,000 is for the collection of data concerning the present cost of generation, transmission and distribution of electrical energy and data concerning the control and utilization of national water resources, including location, capacity, development costs and relation of power sites to markets; also data concerning the relation of the hydro-electric industry to other industries.

FOUNDATIONS FOR THE SPILLWAY DAM AT BONNEVILLE

This picture, taken with the aid of the floodlights that make nightwork possible within the cofferdam at Bonneville Dam, shows the foundations for the south half (Oregon side) of the spillway across the main channel of the Columbia River. Painted on the far wall of the cofferdam (lying about midstream) is the rock profile of the bottom of the dam, the upstream cut-off trench being at the right. A section of this trench is seen in the center foreground. For a section of the spillway see *ENR* Nov. 1, 1934, p. 549. About 76,000 cu.yd. had been placed when this photo was taken, and concrete was going in at the rate of about 2,000 cu.yd. every 24 hours.

At the top of the picture, on the Washington shore, is the Columbia Construction Company's aggregate plant, left, and concrete plant, center.

Chicago Gets Added PWA Funds For Outer Drive Completion

PWA Administrator Ickes has announced two allotments totaling $2,324,181 to the Chicago Park District as a PWA grant to complete the Chicago outer drive bridges and their approaches and the Randolph Street Viaduct, thus linking North and South Sides of the city with a continuous high speed thoroughfare.

At the same time, Administrator Ickes announced two other important decisions favorably affecting Chicago's participation in the federal works program, providing the city with public works of permanent value and giving jobs to thousands of its unemployed. The Administrator has agreed conditionally to purchase $6,000,000 of Chicago Park District bonds to enable the district to obtain the benefits of a WPA program calling for the expenditure of more than $15,000,000 for park improvements. The district has given assurance that the validity of the bond proceedings will be approved by its bond counsel.

Important traffic artery

One of the most impressive municipal improvements in the country, the Chicago outer drive runs along the shore of Lake Michigan from the far South Side of the city to the Loop. Across the Chicago River, the drive continues along the lake, serving the North Side of the city.

With the proceeds of the PWA grant and its own funds, the park district will complete bridges across the Chicago River and its own funds, the park district will North and South outer drives and permitting through traffic to avoid Michigan Avenue and the Loop.

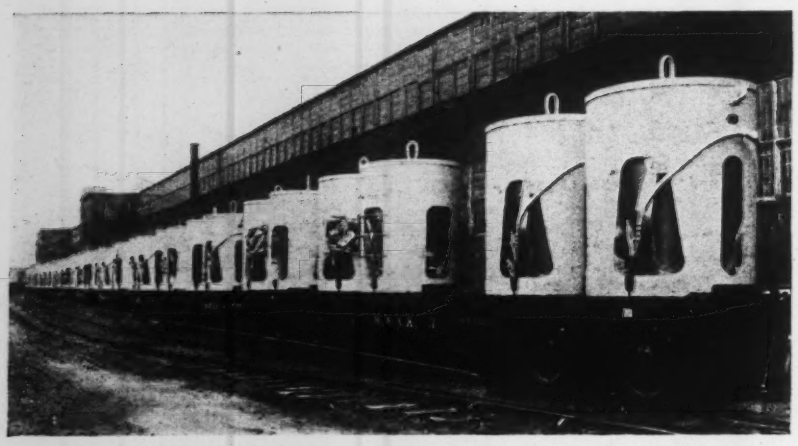
Completion of this outer drive has always been considered one of the most important projects proposed for the PWA program, according to Administrator Ickes, but litigation which followed the consolidation of Chicago park districts in 1933 hampered PWA's efforts to assist the new park district. PWA was forced to revoke the original allotment for the bridge when the two park districts could not provide security meeting the requirements set down. The consolidated park district is now in a position to comply with PWA regulations.

Construction of the outer drive bridges, which include a 70-ft. single-leaf bascule bridge over the Michigan Canal and a two-leaf bascule bridge over the Chicago River, was started some years ago but work was subsequently abandoned because of financial difficulties encountered by the Lincoln Park Board and the South Park Board, predecessors of the present park district.

Status of work

The total cost of the work will be $6,575,000. The park district has requested no loan, but will utilize funds now available in addition to the grant of $1,972,363. The park district's engineering division has informed PWA officials that contracts can be let and work started before Dec. 15, and that all work on the improvement will be completed by the end of 1936.

According to park engineers, the present



TRAINLOAD OF BUCKETS FOR PLACING GRAND COULEE DAM CONCRETE

One of the 40 4-yd. roller bottom dump buckets, shown here leaving the Blaw-Knox plant in Pittsburgh, will place the first yard of concrete in Grand Coulee dam amid appropriate ceremonies on Dec. 6. Gov. Clarence D. Martin, of Washington, will trip the first bucketful, marking the end of a year's preparation work that has cost $23,000,000. The buckets were shipped on special cars designed for the contractor, Mason-Walsh-Atkinson-Kier, which will be used for transporting five buckets at a time from mixing plant to within reach of cranes for final placement of concrete within the forms. The present contract calls for 4,000,000 cu.yd. of concrete to be placed in the base of a dam that will eventually rise to a height of 540 ft., and contain 9,250,000 cu.yd. of concrete, nearly three times the concrete yardage contained in Boulder Dam.

status of construction is as follows: north approach to the canal, complete; canal bridge, 63 per cent complete; north viaduct approach to the river bridge, 22 per cent complete; river bridge, 42 per cent complete; and but little work completed on the south bridge approach.

A PWA grant of $351,818 will enable construction of a viaduct at Randolph Street, connecting Michigan Avenue with the outer drive. This overpass will cross the Michigan Central and the Illinois Central tracks, and the railroads are eventually to share its construction cost. Since the railroads at this time are not in a position to finance their share of the work, only the park district's part of the improvement, costing $1,172,000, will be built now. It will be 1,800 ft. long, and 250 ft. already have been built.

The purchase of $6,000,000 of Chicago Park District bonds to which Administrator Ickes has tentatively agreed is an innovation in PWA procedure. The Illinois General Assembly has approved the issuance of $6,000,000 in bonds for permanent improvements, providing that the bonds be purchased only by a federal agency in connection with a federal grant.

The Chicago park district, in order to take advantage of WPA funds, has offered these bonds for sale. As PWA is the only federal agency which may buy the bonds and thus provide the park district with necessary funds, the Works Progress Administration was notified that the bonds would be purchased by PWA if the following requirements can be met: PWA lawyers must pass on the securities as binding and legal general obligations of the park district; the Reconstruction Finance Corporation must agree to purchase the bonds from PWA; and the President must approve the transaction. PWA's legal division has already asked for the transcript of bond proceedings of the park board, and RFC has indicated its willingness to buy the securities from PWA.

Bay Bridge Catwalk Rope Lost When Lashing Breaks

An accident which occurred on the San Francisco-Oakland Bay Bridge job, Nov. 27, resulted in the loss in the waters of the Bay of one of the side span catwalk ropes, consisting of 1,500 ft. of 2¼-in. diameter cable. Lying on the catwalk between the central anchorage and tower 3, and lashed to the tower the rope was being cut into short lengths to be used as hangers for the floor system, when the lashing gave way. The rope slid down the catwalk and finally went over the side. It started a second rope and half of this went overboard. The ropes raked off about 300 ft. of the catwalk handrail and distorted the walk to some extent but did not break it. No one was hurt and no delay to the project is involved according to a telegraphic report from Charles E. Andrew, bridge engineer of the California Toll Bridge Authority.

Contracts of Most PWA Work Expected by Dead-Line Date

The Public Works Administration expects to have initial contracts let on 75 per cent of its 4,000 projects by the dead-line date, Dec. 15. In a few instances difficulties have been experienced in getting bids, but PWA officials state that communities that have not been able to obtain satisfactory bids will be given consideration on a proper showing.

According to Administrator Ickes, the PWA will permit extensions of the deadline for the award of contracts in particular instances.

To get some operations within the letter of the law, contracts for initial operations, such as foundations, are being let now with contracts for other work to follow.

Personals

SAMUEL VALENSTEIN has resigned his position as resident engineer with PWA and has joined the engineering staff of the TVA. Previously Mr. Valenstein was chief engineer with M. Shapiro & Sons, New York City.

J. L. PHILLIPS, formerly senior resident engineer for the North Carolina state highway commission, has received an appointment as associate highway engineer, U. S. Bureau of Public Roads, with headquarters at Fitzgerald, Ga.

E. A. CHILDERHOSE, senior engineer of the Corps of Engineers, Missouri Division office, Kansas City, and who had been in charge of designs at Fort Peck Dam, has been transferred to the Passamaquoddy project, Eastport, Me.

C. E. BOESCH, president of the Engineers Club, Memphis, Tenn., and a colonel in the Corps of Engineers has resigned his presidency as he has been transferred as assistant to Col. Brehon B. Somervell, who is now in charge of the Florida canal project. W. A. GENTRY, engineer for the Memphis Power & Light Co., has been named president of the Memphis Engineers Club to serve the unexpired term.

GROVER C. DILLMAN, Michigan state highway commissioner from 1929 to 1933, and a past president of the Mississippi Valley Association of Highway Departments, took office this fall as president of the Michigan College of Mining and Technology. He was unanimously chosen by the college board of control in July as successor to DR. W. O. HOTCHKISS, now president of Rensselaer Polytechnic Institute. Mr. Dillman is a graduate of Michigan State College, from which he holds also the honorary degree of master of highway engineering. After graduating he was employed by the state highway department as draftsman, as chief of survey party, and on general inspection work. He then became assistant district engineer, maintenance engineer, and deputy commissioner and commissioner.

Obituary

FRANK T. REYNOLDS, 77, former general contractor and former commissioner of buildings, Buffalo, N. Y., died Nov. 23, at his home in Buffalo.

ROBERT G. MACKAY, building contractor, died at his home in Yonkers, N. Y., Nov. 24, at the age of 48. Mr. MacKay was formerly secretary of the Association of General Contractors in Westchester County and had helped to organize the Building Trade Employers Association.

F. L. BELKNAP, chief engineer of the Department of Purchase and secretary of the Board of Standardization, New York City, died on Nov. 28. He was 55 years old at the time of his death. Mr. Belknap who first entered municipal employ as an engineer in the Department of Water Supply, had been employed by the city for the past 30 years.

JOHN D. CORMACK, professor of civil engineering and mechanics at Glasgow Uni-

versity since 1913, died on Dec. 1 in Glasgow, Scotland, at the age of 65. Dr. Cormack had been professor of mechanical engineering at University College in London for twelve years before his appointment to the Glasgow professorship and during the war devoted a good deal of time to research work in aeronautics.

HERMAN GUNTHER, of Gunther & Shirley, contractors on the first section of the All-American Canal, died at his home in Los Angeles on Nov. 25 at the age of 57. He was formerly associated with the firm of Peterson, Shirley & Gunther, of Omaha, Neb., active in railroad and other heavy construction in the West, Canada and Cuba. This firm was associated with Callahan Const. Co., of St. Louis, in the construction of the Madden Dam in Panama. Mr. Gunther was a native of Sheboygan, Wis.

WILLIAM G. AMES, 62, died at Tucson, Ariz., on Nov. 24. He graduated from Vanderbilt University and received his first engineering experience in connection with the building of the first subway in New York. He later became a member of the construction staff of the Cuba Railway and after spending many years in the construction of railroads and sugar mills in Cuba, formed the engineering firm of Smith & Ames in Havana and continued in the designing and construction of sugar mills. In 1926 Mr. Ames, because of his extensive experience, was given charge of the construction of the raw sugar house in Clewiston, Fla., for the Southern Sugar Co.

CONSTRUCTION STATISTICS OF THE WEEK

THIS WEEK'S engineering construction volume is the third largest this year, $49,345,000. State and municipal awards continue heavy and private awards are higher than for six weeks. The amounts are private, $11,577,000; public, $37,768,000; federal, $4,941,000 and state and municipal, $32,827,000, the second highest week this year. Corresponding values last year are: total, $26,238,000; private, $2,294,000; public, $23,944,000; federal, $6,850,000; state and municipal, $17,094,000.

Highway awards continue heavy, totalling $10,753,000 for the week, public buildings at $12,058,000 are almost double last week's awards. Unclassified awards, including railroad rail purchase are higher at $9,694,000. Other classifications include, waterworks, $4,246,000; sewerage, $1,989,000; bridges, $4,539,000; earthwork, irrigation, waterways, $2,979,000; commercial buildings, $1,533,000; industrial buildings, $1,554,000.

The larger awards for the week include: residential development, Tonawanda, N. Y., $400,000; college buildings, University of Missouri, Columbia, Mo., $523,000; school, Detroit, Mich., $1,033,000; college buildings, University of Indiana, Bloomington, Ind., $465,000; highway awards, Indiana, $509,000; Missouri, $1,208,000; Wyoming, $572,000; Michigan, $714,000; Pennsylvania, $877,000; Minnesota, $517,000; Mississippi, $917,000; bridges, by New York state, $928,000; West 79th St. grade crossing elimination, New York, N. Y., $1,631,000; intake and pumping plant buildings, inlet works, outlet structures and appurtenant works, Metropolitan Water District, Los Angeles, Calif., $1,732,000; waterworks improvements, Rochester, N. Y., $585,000; lock and guide wall, on Illinois River, Peoria, Ill., $1,654,000; dredging Christ Pass Channel at Chapalaya Basin, $594,000; repairing hurricane damages to distribution system in Miami and vicinity, Florida Power & Light Co., $750,000; 200,000 tons of rails and 1,400 tons of fastenings, C. B. & Q. R.R., Chicago, Ill., $7,500,000.

State and municipal bond sales for the week total $10,066,000 plus $5,181,000 in PWA bonds sold to private investors by RFC. A PWA loan allotment of $37,500,000 to the Midtown Tunnel, New York, was changed to a grant of $4,780,000 with no loan. The net return to the revolving PWA fund is $27,179,000.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Dec. 1934	Prev. 4 Weeks	Week Dec. 5 1935
Federal Government	$3,979	$3,797	$4,941
State and municipal	15,399	28,871	32,827
Total public	$19,378	$32,668	$37,768
Total private	5,977	6,075	11,577
Week's total	$25,355	$38,743	$49,345

Cumulative to date:
1934..$1,285,415,000 1935..$1,403,990,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

1935	Week Dec. 5	Cumulative
State and municipal	$15,247*	$408,353*
PWA allotments, S&M	—27,179*†	760,740*†
RFC loans, S&M	.....	48,180
Corporate issues	.....	27,738
PWA private	.....	9,086
Local contrib. to WPA	.....	31,861
Total non-federal	—$11,932	$1,285,958
PWA federal	1,442	1,349,479
Total new capital	—$10,490	$2,635,437

Cumulative to date:
1934..$1,210,196,000 1935..$2,635,437,000

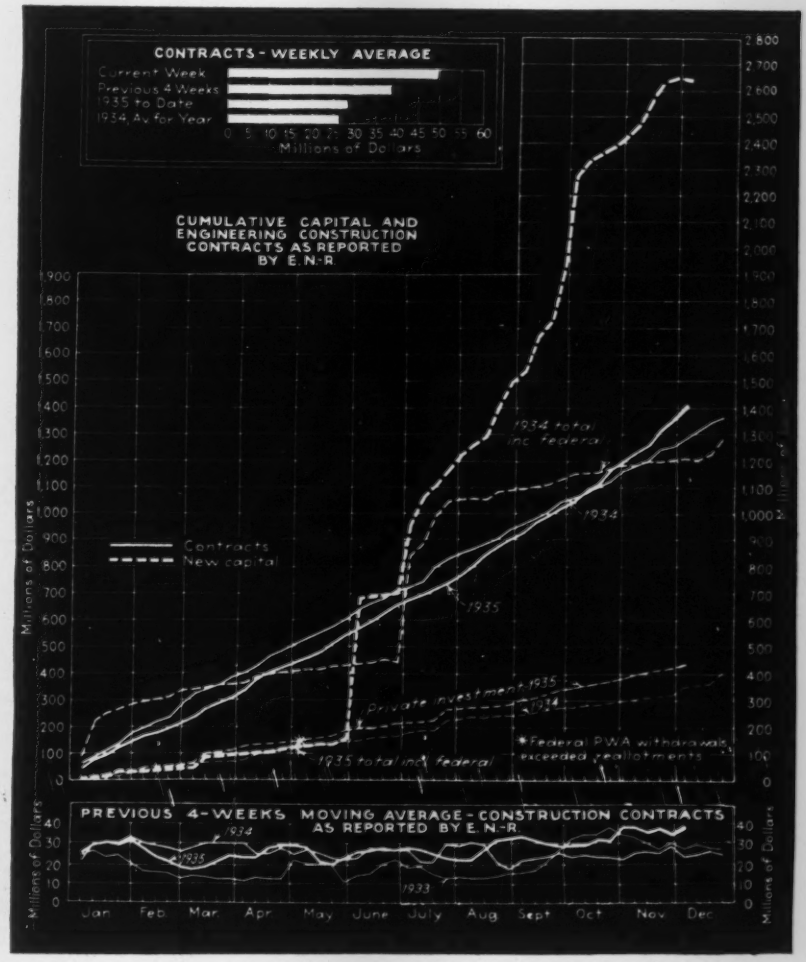
*Includes transfer from federal to private through sale by RFC of PWA bonds.

† Indicates balance from loan allotment changed to smaller grant allotment. Means funds returned to revolving fund and available for reallotment.

Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds. An arbitrary percentage (25%) of the WPA allotments and local contributions to WPA work is included to allow for the capital additions through the Works Progress Administration division of the new program.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
Dec., 1935	194.90	93.69	Nov., 1935	171	75
Nov., 1935	194.90	93.69	Oct., 1935	162	71
Dec., 1934	201.86	97.00	Nov., 1934	98	43
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56



BUSINESS SIDE OF CONSTRUCTION

November Extends Contracts Gain State and Municipal Awards Up

ENGINEERING construction awards set a new high pace in November in spite of 3 legal holidays which reduced the number of days for opening bids. The 4-weeks total is $154,973,000 of which $24,301,000 is private and $130,672,000 public. Of the latter, $15,187,000 is federal and $115,485,000 state and municipal, almost a 100 per cent increase over the previous rate. Corresponding values last year are for a 5-weeks month: total, $134,148,000; private, $19,132,000; public, $115,016,000; federal, $31,662,000; state and municipal, $83,354,000.

Highway awards, waterworks and sewerage are responsible for the gain over last month. Highways for the 4 weeks totalled $42,028,000. Building awards were lower than last month, but well ahead of last year. They totalled for public buildings, $19,584,000; industrial buildings, $8,551,000; commercial buildings, $11,237,000.

Geographically, all territories are ahead of last month except Middle West which shows a rather sharp drop. All territories are, however, ahead of November last year.

New capital

State and municipal bonds sales continued strong throughout November and added $36,155,000 to the private investment capital chart. More WPA allotments were rushed through. Total new capital recorded through November is $2,645,927,000 for 1935 compared with $1,204,033,000 for 1934.

Materials

Cement—Cement shipments in October totalled 8,794,000 as reported by the Bureau of Mines. This is an increase of 4.1 per cent over October a year ago. Stocks at mills were 2.6 per cent higher than a year ago. The output of a new plant located in Idaho, which began producing during the month, is included in this month's statistics which are compiled from reports for October, received by the Bureau of Mines, from all manufacturing plants except one.

Steel—The average operating rate of steel companies having 98.2 per cent of the steel capacity of the industry reporting to the American Iron and Steel Institute was 53.2 per cent during November compared with the preceding week's average of 52.5, the preceding month's average of 50.9 and the corresponding 4-weeks' average in 1934 of 27.3 per cent. The trend was up from 50.9 per cent in the first week of November to 55.4 per cent for the last week.

Orders for fabricated structural steel booked during October were 12 per cent

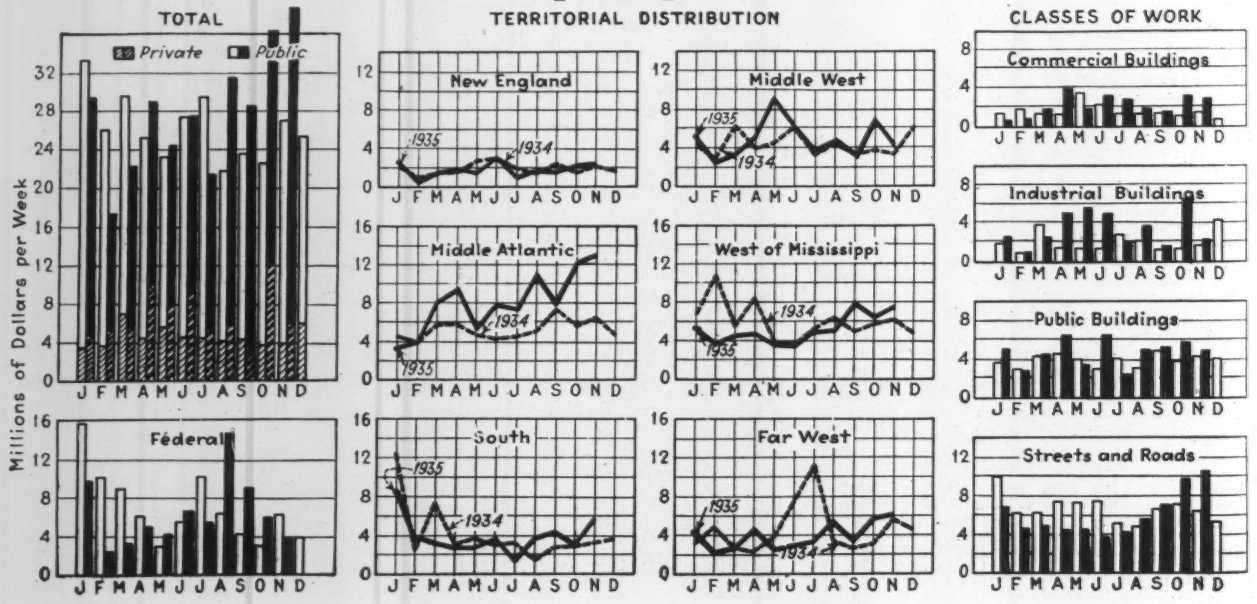
ENGINEERING CONSTRUCTION CONTRACTS REPORTED IN NOVEMBER, 1935

Four Weeks—Thousands of Dollars (000 Omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States November 1935	United States Eleven Months 1935	United States Eleven Months 1934	Canada
Public Works										
Waterworks	327	840	704	139	1,211	3,919	**7,140**	66,202	78,404	118
Sewerage	3,588	8,482	759	766	2,088	10,558	**26,241**	83,681	56,242	
Bridges	472	3,241	376	2,112	3,196	920	**10,317**	69,783	83,492	188
Earthwork and waterways	363	1,756	6,009	243	250	1,081	**9,702**	210,417	252,583	51
Streets and roads	1,615	7,848	7,081	7,408	13,892	4,184	**42,028**	292,201	323,766	103
Buildings, public	1,985	6,870	3,545	1,219	5,122	843	**19,584**	226,261	187,925	664
Unclassified, public	141	12,247	222	747	1,563	740	**15,660**	63,374	59,409	142
Total public	8,491	41,284	18,696	12,634	27,322	22,245	**130,672**	1,011,919	1,041,821	1,266
Federal gov't (included in above classifications)	759	2,076	7,397	589	2,750	1,616	**15,187**	304,074	344,251	....
Private										
Bridges, private	....	521	....	....	....	....	**521**	10,957	10,044	
Buildings, industrial	318	1,301	960	4,173	1,158	641	**8,551**	163,565	88,070	646
Buildings, commercial	500	7,957	1,295	285	....	1,200	**11,237**	103,687	77,622	275
Unclassified, private	225	149	2,180	113	1,159	166	**3,992**	64,517	41,620	17
Total private	1,043	9,928	4,435	4,571	2,317	2,007	**24,301**	342,726	217,356	938
November, 1935 (4 weeks)	**9,534**	**51,212**	**23,131**	**17,205**	**29,639**	**24,252**	**154,973**	....	....	**2,204**
October, 1935 (5 weeks)	11,177	60,429	15,628	34,194	32,584	28,619	**182,631**	....	....	12,678
November, 1934 (5 weeks)	10,768	32,218	16,066	16,276	30,671	28,149	**134,148**	....	....	4,594
Eleven months, 1935	86,245	390,816	189,887	240,069	251,563	196,065	....	1,354,645	....	80,586
Eleven months, 1934	93,932	254,738	200,179	202,531	291,242	216,555	....	....	1,259,177	43,231

ENGINEERING CONSTRUCTION REPORTED BY E.N.-R.—WEEKLY AVERAGES

□ ---1934 ■ —1935



larger than the monthly average for 1935, according to reports received by the American Institute of Steel Construction. Shipments were approximately equal to the monthly average of the year. Production during October was at the rate of 32.2 per cent of normal (normal being the yearly average for the years 1928 to 1931 inclusive). Estimated total tonnage for the entire industry for October is 91,901 (subject to revision) compared with 98,824 for September and 123,622 tons for August.

Lumber—Lumber shipments were lower in November, averaging about 202,000,000 feet as reported by the National Lumber Manufacturers Assn. Production is running 30 to 45 per cent above a year ago.

Index of Shipments—The Space Control, Advance Construction Programs Unit index of shipments of construction materials, based on thirty individual series and 1929 = 100, reports 77 (subject to revision) for October compared with 71 for September and 65 for October, 1934.

Building permits

Building permits issued during October in 215 cities of the United States were valued at $67,013,939, according to Dun & Bradstreet, Inc. This was the largest monthly total reported so far this year and set up a new high mark in the building industry since October, 1931. The October figure compared with $47,479,944 in September and $37,501,122 in October, 1934. This is an increase of 41.1 per cent over September, which greatly exceeds the normal seasonal gain of about 2.5 per cent expected for this period. The rise over October of last year amounted to 78.7 per cent.

More than doubling the volume of September and the same month of last year, New York City accounted for the major portion of the gain in building last month. Every borough reported sharp gains, the total permit volume for the city as a whole amounting to $21,474,945 during October, compared with $9,227,037 in September and $8,360,972 in October a year ago. This represented increases of 132.7 and 156.9 per cent, respectively.

The record for the 214 cities outside of the Metropolis was also distinctly favorable, the October permits aggregating $45,538,994, compared with $38,252,907 in the preceding month and $29,140,150 in October, 1934.

The Bureau of Labor also reported a substantial gain in building permits: "The most pronounced increase over the previous month was in the value of residential construction which showed a pick-up of more than 34 per cent. Virtually all parts of the country shared in the increase. The value of all building construction for which permits were issued during the month increased 17.6 per cent, the total valuation being $87,145,000 for 753 cities compared with $74,100,000 in September. Compared with a year ago, the value of buildings for which permits were issued shows an increase of 78.1 per cent. The October permit valuation for residential buildings was nearly three times as great as during the same month of the preceding year. The value of both residential and non-residential construction in October, 1935, was greater than in the corresponding month of any year since 1931."

Labor

Employment in the production of six major construction materials as reported by Advance Construction Programs Unit, Space Control, advanced to 48.2 in October, compared with 47.6 in September, 46.6 in August and with 41.3 in October last year.

Employment in the private building construction industry remained practically unchanged from September to October according to the Bureau of Labor statistics. Based on reports received from 9,851 contractors employing 92,747 workers in October, 1935, there was a decline of less than one-tenth of 1 per cent in employment and a gain of 0.1 per cent in pay rolls. The figures relate to employees engaged in the erection, alteration, and repairing of buildings and do not include projects financed by the Public Works Administration or Reconstruction Finance Corporation funds, regular appropriations of the Federal, State and local governments, or by loans insured by the Federal Housing Administration.

Employment at the site of construction projects financed from the Emergency Relief Act of 1935 increased by more than 300,000. There were more than 650,000 workers employed on this program on October 15. Monthly pay rolls totalled nearly $31,000,000.

Employment on the Public Works Administration program declined slightly during the month. There were 320,000 workers employed as of October 15, a decrease of 20,000 as compared with September. Pay rolls for the workers approximated $21,000,000. The employment decline was almost wholly confined to road building. All other types of construction showed increases.

Employment on construction projects financed from regular governmental appropriations increased by nearly 15,000 during the month. Approximately 60,000 workers were employed on these projects. They drew nearly $4,000,000 for their months' pay.

There were 188,000 men engaged in the construction and maintenance of State roads during the month ending October 15. This is a decrease of approximately 9,000 as compared with the previous month. Pay rolls for October totalled $8,150,000.

Employment in the construction industry in New York State dropped 1.1 per cent from August to September. Man-hours dropped 2.1 per cent while paprolls showed no change. Increases of 4.2 per cent for miscellaneous general contracting and 3.5 per cent for subcontracting were offset by lowered employment for general building and highway contracting. Decreases amounted to 8.3 per cent for general building contracting and 4.8 per cent for highway contracting as reported by Division of Statistics and Information, Department of Labor, State of New York. From September to October, construction employment, payrolls and hours in New York State showed a slight rise. Percentage increases amounted to 0.3 per cent in employment, 1.9 per cent in payrolls and 1.2 per cent in hours. Increases in employment amounted to 3.8 per cent for general building and 5.2 per cent for miscellaneous general contracting. A decrease amounting to 7.2 per cent was shown for highway contracting and 1.3 per cent for subcontracting. These statements are based on the reports of more than 1,300 firms reporting monthly.

Labor controversies during the month centered almost entirely in WPA rates and were reported from all sections of the country. Settlement was effected through widespread revision of original WPA policy to meet demands of organized labor.

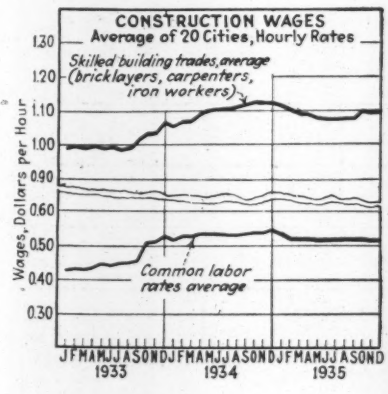
ENR Cost and Volume Index

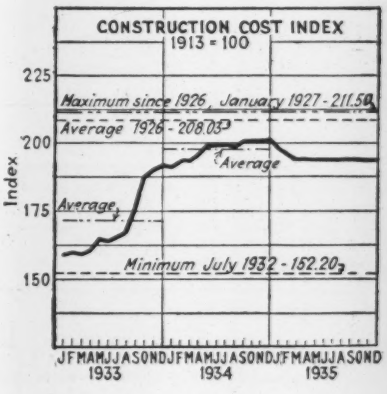
The *Engineering News-Record* Construction Cost Index remains at 194.90 for December.

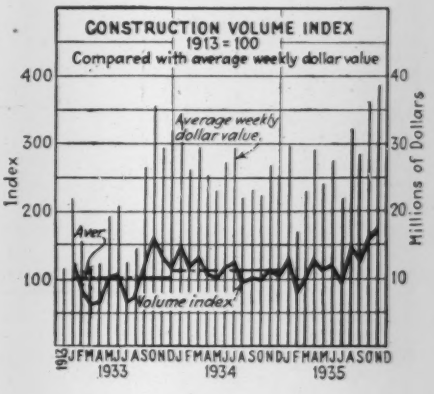
The *ENR* Volume Index is 171 for November, the highest value since November, 1931.

INDEX NUMBER

ENR Cost	1913 =100	1926 =100	ENR Volume	1913 =100	1926 =100
Dec., 1935	**194.90**	**93.69**	**Nov., 1935**	**171**	**75**
Nov., 1935	194.90	93.69	Oct., 1935	162	71
Dec., 1934	201.86	97.00	Nov., 1934	98	43
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
1933 (Av.)	170.18	81.80	1933 (Av.)	102	47
1932 (Av.)	156.97	75.45	1932 (Av.)	127	56


CONSTRUCTION WAGES
Average of 20 Cities, Hourly Rates
Skilled building trades, average (bricklayers, carpenters, iron workers)
Common labor rates average
Wages, Dollars per Hour
1.30
1.20
1.10
1.00
0.90
0.60
0.50
0.40
0.30
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935


CONSTRUCTION COST INDEX
1913 = 100
Maximum since 1926, January 1927 - 211.50
Average 1926 - 208.03
Average
Average
Minimum July 1932 - 152.20
Index
225
200
175
150
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1933
1934
1935



CURRENT PRICES OF CONSTRUCTION MATERIALS

CEMENT, AGGREGATES AND READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT (Per bbl., carload lots, including 40c. per bbl. for bags, cash discount not included)			SAND AND GRAVEL (Per ton, carload lots)			CRUSHED STONE (Per ton, carload lots)		CRUSHED SLAG (Per ton, carload lots, f.o.b. plant)		CONCRETE (Ready-mixed 1:2:4, 5 sacks per cu. yd. or more, delivered)
	Cloth Bags*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.89	$2.64	$2.44	$2.31	$2.31	$1.64	$1.69	$1.92	$1.80	$1.80	$8
Baltimore	2.69	2.44	2.24	1.80‡	1.80‡	1.30‡	1.80‡	1.80‡	2.25	2.25	7
Birmingham	2.55	2.30	2.10	1.75	1.75	1.40	.85	.85	.90	1.15	5.4
Boston	2.42	2.17	1.92	1.44	1.54	1.90	1.40	1.40	.....	.....	6.
Chicago	2.85‡	2.60‡	2.40	2.60‡	2.60‡	2.05‡	2.60‡	2.60‡	.....	.....	.....
Cincinnati	2.50	2.25	2.05	1.20	1.20	1.10	1.80	1.80	.....	.....	6.7
Cleveland	2.26	2.01	.....	1.40	1.40	1.30	1.60	1.60	1.75	1.75	7.
Dallas	2.45	2.20	2.00	1.55	1.55	1.30	2.10	2.25	.....	.....	7.0
Denver	3.09	2.84	.....	1.85	.....	1.25	.....	.....	.....	.....	.....
Detroit	2.26	2.01	1.81	1.30	1.30	1.20	1.40	1.60	1.40‡	1.50‡	6.7
Kansas City	2.50	2.25	2.05	.....	1.85	1.25	1.85	1.80	.....	.....	7.6
Los Angeles	2.25	2.05	.....	1.40	1.40	1.00	1.40	1.40	.....	.....	6.7
Minneapolis	2.90	.....	2.45	1.00p	1.00p	.25p	1.00p	1.00 p	.....	.....	5.7
Montreal	.....	1.70	.....	.85	.90	1.25	.85	1.20	.....	.....	4.5
New Orleans	2.47	2.22	2.00	1.75	1.75	1.45	.....	.....	.....	.....	8.2
New York	2.30‡x	2.05‡x	.....	1.40†*	1.40†*	.75†*	1.75†*	1.85†*	.....	.....	8.00
Philadelphia	2.63	2.38	2.18	1.80‡	1.90‡	1.50‡	2.60‡	2.75‡	1.00‡	1.00‡	7.7
Pittsburgh	2.46	2.21	1.61	1.50‡	1.50‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.00
St. Louis	2.53	2.28	.....	1.40‡	1.40‡	1.40‡	.75p	.75p	.75§	.75§	6.6
San Francisco	2.72	2.52	2.20	1.35	1.35	1.35	1.50	1.50	.....	.....	7.5
Seattle	3.09	2.84	.....	1.00	1.00	1.00	1.44	1.44	.....	.....	7.5

*10c. allowed for each returnable bag. †Per cu. yd. ‡Delivered. §F.o.b. Granite City, Ill. *Barge lots alongside dock. pf.o.b. plant. ₤5 tons or more. pWithin 6-mi. z
xFor delivery via Erie Basin only. Subject to change without notice. ₤ ton.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Alpena, Mich	$1.50	$1.45	Ironton, Ohio	$1.50	$1.45	North Birmingham, Ala	$1.75	$1.70
Buffington, Ind	1.70	1.65	Iola, Kans	1.70	1.65	Richard City, Tenn	1.85	1.80
Crestmore, Calif	1.72	....	La Salle, Ill	1.70	1.65	Saginaw, Mich	1.50	1.45
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind	1.70	1.65	Steelton, Minn	1.80	1.75
Hannibal, Mo	1.70	1.65	Mason City, Ia	1.70	1.65	Universal, Pa	1.65	1.60
Hudson, N. Y	1.75	1.70	Norfolk, Va	1.76	1.71	Waco, Tex. (Inc. 5c. Tax)	1.80	1.75
Independence, Kans	1.70	1.65	Northampton, Pa	1.65	1.60	Wyandotte, Mich	1.45	1.40

Cash Discounts, Cement, to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount, 10c. per bbl. for payment within 15 days of date of invoice.

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE—PARTITION—SCORED (Per M, lots of 2,000 pieces or over)			STRUCTURAL CLAY TILE—LOAD BEARING—SCORED (Per M, lots of 2,000 pieces or over)			BRICK (Per M, in quantity)		LIME		
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Per ton, Hydrated finishing	in paper, Common hydrated	carload lot, Pulverized or lump
Atlanta	$75.80	$80.80	$151.60	$181.90	$212.20	$242.50	$14.25	$14.25	$24.00	$17.00	$15.90
Baltimore	91.00	98.00	183.00	219.00	315.00	390.00	13.00	17.00	17.00	12.50	19.25
Birmingham	78.75	84.00	157.50	189.00	201.25	242.00	15.00	22.50	3.00§	1.75§	2.25§*
Boston	84.40₤	90.00₤	168.75₤	191.25₤	246.75₤	282.00₤	14.50	18.00	20.00	15.50	3.50q
Chicago	66.00	70.40	132.00	.....	.....	.....	10.20	11.20	18.00	13.40	14.00
Cincinnati	55.00	58.70	110.00	124.10	164.20	187.70	17.50	17.50	15.97	12.48	.....
Cleveland	45.00	48.00	90.00	108.00	138.50	158.50	13.00	13.00	16.00k	14.00k	2.65kp
Dallas	72.00	75.00	197.00	177.00	217.00	269.00	13.50	26.00	21.20	14.50	1.70p
Denver	78.50	88.00	141.50	166.50	196.00	225.00	10.00–15.50	21.00–30.00	25.00	17.00	20.00
Detroit	71.85	76.65	143.70	230.00	280.00	325.00	11.50	12.50	14.25	11.90	22.20
Kansas City	72.50	72.50	92.00*	140.50	177.75	207.25	15.00	24.00	18.00	11.89	14.20*
Los Angeles	77.50	94.25	134.00*	188.00	232.50	311.50	11.50	14.00	18.70	.....	19.70
Minneapolis	80.15s	85.50s	145.40s	167.75s	175.25s	243.70s	13.10	15.10x	25.50	21.00	23.00
Montreal	79.10s	90.40	169.50s	.....	212.40	136.60	20.75	31.00	15.00	10.00	7.00
New Orleans	61.60	65.10	123.20	158.90	196.70	.....	14.00	.....	16.75	13.05	.....
New York	84.00	90.00	135.00*	193.30†	238.80†	295.60†	10.00	.....	20.00	15.50	20.00
Philadelphia	76.00	80.00	150.00	172.00	240.00	295.00	18.00	20.00	16.35	11.25	10.75
Pittsburgh	58.40c	62.30c	116.85c	165 00c	217.00c	250 00c	15 00	22.00	17.20	14.50	2.22p
St. Louis	62.00	65.00	120.00	180.00	234.00	280.00	15.00	18.00	.55‡	.40‡	2.30p
San Francisco	84.00	94.50	225.00	.....	.....	.....	15.00	18.00	22.50	21.50	2.05e
Seattle	86.00	94.50	210.00	198.00	198.00	198.00	15.00d	18.50	30.00	26.00	3.00e

*6x12x12 in. †F.o.b. Perth Amboy, N. J. ‡Per sack. §Per bbl., 200 lbs. pPer bbl. 180 lbs. qper bbl. 280-lb. kLCL. dless $1 cash 15 days. elump.
sSmooth. xSelected common. rCarload lots delivered to job.

ROAD SURFACING MATERIALS—F.O.B. CITY

	PAVING BRICK AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION	
	Granite per M, lots of 50,000, 4x4x8 in.,	Brick per M, 3x4x8½ in., carload lots	Wood per sq. yd., 3½ in., 16-lb. treat,	Per ton, less than 80 penetration, Tank car	Drums	Per gal., 80-300 penetration, Tank car	Drums	Per ton, Tank car	Drums	Per gal., Tank car	Per gal., Tank car	Drum
Atlanta	$ 75.00	$35.00	$2.25	$17.40z	$22.57z	$0.0644#	$0.911z	$15.90z	$23.82z	$0.0586z	$0.085	$0.085
Baltimore	110.00	44.00	2.35	17.00	22.00	.07	.095	.085†	.12†	.....	.....	.....
Birmingham	110.00	24.00	....	18.00	23.00	0.778	.1028	.082†	.112†	.....	.06	.....
Boston	75.00	28.60	2.50	16.00	21.00	16.50#	21.50#	.09†	.12†	.075	.09	.125
Chicago	125.00	42.00	2.60	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cincinnati	115.00	37.00	....	18.00	22.00	.09	.....	18.50	.....	.07	.08	.....
Cleveland	100.00‡	32.75	2.85	19.00	23.25	.075	.085	.075†	.0425†	.06	.085	.10
Dallas	.....	30.00	....	17.30	22.30	.0575	.105	16.85	24.35	.06	.1126	.1488
Detroit	.....	37.00	....	19.67z	24.87z	.....	.....	17.00	22.50	.055	.11	.15
Kansas City	.....	45.00	....	18.50	23.50	17.50#	22.50#	.077†	.107†	.057	.11	.15
Los Angeles	.....	50.00	....	10.34	14.50	10.34#	14.50#	10.34	.....	.042	.06	.12
Minneapolis	.....	.....	2.50	18.20	24.70	.098	.098	21.85	34.65	.048	.....	.....
Montreal	70.00	60.00	3.62	14.00	19.66	.07	.093	19.00	26.50	.07	.135	.165
New Orleans	100.00	32.00	....	14.50	18.50	.0655	.09	.07†	.10†	.....	.....	.....
New York	130.00§	65.00	2.64	17.00	22.00	.07	.095	.085†	.12†	.....	.075	.11
Philadelphia	122.00	45.00	2.25	13.50	18.00	.05	.08	.05†	.08†	.045	.08	.....
Pittsburgh	115.00	40.00	....	19.00	24.00	.0775	.1125	.086†	.121†	.0675	.....	.....
St. Louis	115.00	35.00	2.00	18.50	23.50	.0775	.1075	.875†	11.75†	.04	.09	.125
San Francisco	.....	50.00	....	12.00	18.00	12.00#	18.00#	12.50#	23.00#	.04	.0575	.117
Seattle	.....	55.00	....	25.50	25.50	17.00#	23.00#	15.00	.....	.03	.19	.20

Note: Paving asphalt, tank car or boat, f.o.b. Maurer, N. J., per ton, Bermudes, $25.00; Trinidad, $21.00. *Per sq. yd. †Per gallon. ‡4½x6x5½ in. #Per ton
§4x5x9-in. Av. zMexican. xLocal reduction due to 20% reduction intra-state class freight rates, only Georgia affected.

CURRENT PRICES OF CONSTRUCTION MATERIALS

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS	RIVETS	WIRE NAILS	SHEET PILING	STEEL RAILS (Per Gross Ton)			TRACK SUPPLIES			
						Standard	Light	Re-rolled	Angle bars	Std. spikes	Tie plates	Track bolts
Birmingham	$1.95	$2.10	¾-in. billet, ¾-in. structural	.....	.....	$36.375	$34.375	$35.00	$2.55	$2.40	$1.90	$3.55
Chicago	1.85	2.10	$3.00	.....	$2.25	36.375	35.00	34.00	2.55	2.40	1.90	3.55
Pittsburgh	1.80	2.05	2.90	$2.40	2.15	36.375	35.00	34.00	2.55	2.40	1.90	3.55

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

F.O.B. WAREHOUSE	STRUCTURAL SHAPES Per 100 lb., base price	REINFORCING BARS Per 100 lb., ¾ in., base price		EXPANDED METAL LATH —Per 100 sq.yd., carload lots—		WELDED FABRIC REINFORCING —Per 100 s.f., carload lots—		6x6 in., No. 6 & 6 wires Per sq.yd.	SHEET PILING Per 100 lb. base price
		New billet	Rail steel	Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires		
Atlanta	$3.36	$2.34	$2.19	$21.00	$23.00	$1.53	$1.16	$0.1449	$2.70
Baltimore	3.00	2.75	2.60	25.00	28.00	1.41	1.08	.1332	2.90
Boston	3.54	2.923	1.925	20.00†	22.00†	1.46	1.12	.1449	2.60
Chicago	3.20	1.85	1.95	22.50	26.00	1.40	1.08	.1323	2.25
Cincinnati	3.40	3.25	3.25	25.01	29.50	1.39	1.07	.1287	.....
Cleveland	3.31	2.75	2.60	29.00	22.00	1.37	1.06	.1287	.....
Dallas	2.605	2.805	2.30	22.00	25.00	1.63	1.23	.1548	3.005
Denver	3.95	3.76	3.61	22.00	25.00	1.68	1.26	.1548	.....
Detroit	3.42	2.20	2.05	20.00†	22.00†	1.41	1.08	.1323	2.43
Kansas City	3.75	2.75	2.60	19.00	21.00	1.50	1.14	.1422	2.69
Los Angeles	3.10	2.525	.....	23.00	27.50	1.68	1.26	.1548	2.65
Minneapolis	3.45	2.86	2.71	22.00	26.00	1.51	1.15	.1431	2.57§
Montreal	3.15	2.40	2.30	25.50	28.75	2.30	1.71	.238	2.80
New Orleans	.....	.....	.....	19.15	23.00	1.54	1.17	.1458	.....
New York	3.37	2.50	2.35	18.50	20.50	1.44	1.11	.1359	2.50
Philadelphia	2.98	3.06	2.22	20.00	24.00	1.42	1.09	.1332	2.46
Pittsburgh	1.80‡	1.80‡	1.70‡	20.00‡	22.00‡	1.34	1.04	.1260	2.15
St. Louis	3.45	2.95	2.80	20.00	22.00	1.42	1.09	.1341	2.25
San Francisco	3.50	2.475	2.325	23.00	28.00	1.68	1.26	.1584	2.60
Seattle	3.55	2.50	.....	30.00	33.00	1.68	1.26	.1584	2.60

‡Base Mill Price. Note: Shapes, bars and piling subject to quantity discounts. §Mill Price plus freight to Minneapolis. ††f.o.b. delivered.

PAINTING AND ROOFING SUPPLIES—F.O.B.

	RED LEAD Per 100 lb. in 500-lb. lots Dry	WHITE LEAD Per 100 lb. in 500-lb. lots# in oil	READY-MIXED PAINT Per gal., drums			ROOFING SUPPLIES Carload lots, f.o.b. factory				
			Graphite*	Aluminum†	Ferric Oxide‡	Rolls, slate surfaced, 85-90 lb., per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating, per gal	Tar pitch, 350-lb. bbl., per ton
Atlanta	$7.75	$10.50	$1.60	$3.10	.....	$1.79	$1.97	$2.90	$.36	$25.40
Baltimore	7.00	10.00	1.40	2.25	$1.90	2.35	2.55	2.55	.48	25.00
Birmingham	7.25	10.50	2.35	2.35	1.85	1.70	1.79	.....	.36	21.88
Boston	7.00	10.00	1.75	2.60	.04½x	1.80	3.25	3.25	.40	20.00
Chicago	7.00	10.00	1.85	2.45	1.30	1.60	1.59x	1.59x	.24	20.00
Cincinnati	7.00	10.00	1.45	2.50	1.40	2.40	2.39x	2.39x	.36	21.00
Cleveland	7.00	10.00	1.65	2.30	1.30	1.60	1.79	1.79x	.24	20.00
Dallas	7.25	11.00	1.80	2.24	.....	2.15x	3.65	3.65	.16	37.50
Denver	7.50	10.75	2.55	.....	.....	2.75	3.46	3.46	.60	30.00
Detroit	7.00	10.00	1.55	2.20	1.30	2.55	2.80	2.55	.35	30.00
Kansas City	7.00	10.12½	1.25	1.65	1.00	2.05	3.10–3.20	3.10–3.20	.23	26.50
Los Angeles	7.25	10.25	1.60	2.25	2.30	2.00	1.50	.....	.45	.....
Minneapolis	7.00	10.12½	.....	.....	.....	1.60	1.79x	1.79x	.29	25.30
Montreal	.....	8.20	1.85	3.50	1.85	1.90	2.44	1.88	1.40§	1.52§
New York	7.00	10.00	1.60	2.25	1.40	1.60	1.79x	1.79x	.232	22.00
Philadelphia	7.00	10.00	2.50	2.95	1.50	1.68	1.86x	1.48x	.37	22.00
Pittsburgh	7.00	10.00	1.05	1.95	.80	1.75	1.65x	1.65	.38	25.00
St. Louis	10.00	10.00	1.85	2.45	1.30	1.76x	3.00	3.00	.26	25.00
San Francisco	7.25	10.25	1.80	2.75	1.10–2.00	1.89	3.10	3.10	.38	26.00
Seattle	7.25	10.25	1.80	2.85	2.20	3.30	2.66	2.60	.60	30.00

*U. S. War Dept. Spec. 3-49A. †ASTM Spec. D266-31. ‡80% maximum ferric oxide. §Per 100 lb. xPer roll, 65 lb. xPer lb.
Note: Red lead in oil 50c higher than white lead in oil. #Basis of quoting changed this month from list to 500-lb. lots.

MISCELLANEOUS ITEMS

	WINDOW GLASS Discounts from latest jobbers List, Sept. 15, 1928 Single or Double Thickness		EXPLOSIVES Per lb. dynamite delivered 50-lb. cases Gelatin	
	A quality	B quality	40%	60%
Atlanta	85%	85%	$0.155	$0.17
Baltimore	88–10%	90–10%	.16	.175
Birmingham	88%	90%	.105	.120
Boston	88–10–5%	90–10–5%	.55	.17
Chicago	90%	92%	.....	.....
Cincinnati	89–10%	91–10%	.27	.29
Cleveland	85–10%	85–10%	.19	.205
Dallas	86%	88%	.17	.185
Denver	86%	88%	.155	.17
Detroit	87–10%	89–10%	.225	.240
Kansas City	88–10%	86–10%	.16	.175
Los Angeles	90%*	90–40%	.1725†	.1925†
Minneapolis	86%	88%	.175	.19
Montreal	30%	70–5%	.1875	.2125
New Orleans	88%	90%	.19	.22
New York	88%	90%	.225	.24
Philadelphia	88%	90%	.1550	.17
Pittsburgh	88%	88%	.11	.1250
St. Louis	89%	89%	.11	.125
San Francisco	82%	87%	.1575	.1775
Seattle	90–10%	90–20%	.1425	.1575

*Disc. from list Aug. 1, 1929. †F.o.b. Arsenal. ‡Double thickness A & B.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York.	
Bleaching powder, in drums, F.o.b. works, per 100 lb	$2.00@$2.25
Calcium chloride, 77-80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, f.o.b. works, freight equalized with points of competition, per ton	22.00@35.00
Chlorine cylinders, per lb. delivered	.055
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.35
Soda ash, 58%, in paper bags, per 100 lb	1.25
Sulphate of aluminum, commercial, in 100 lb. bags per ton	27.00
Sulphate of copper, in bbl., per 100 lb	3.85

PILES

Prices per linear foot, pine, with bark on f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail	Long Leaf Barge	Long Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.12	$0.165	$0.13	$0.16
12 in.—2 ft. from butt.	6 in.	50 to 59 ft.	.16	.21	.15	.20
12 in.—2 ft. from butt.	6 in.	60 to 69 ft.	.17	.225	.16	.21½
14 in.—2 ft. from butt.	6 in.	50 to 69 ft.	.195	.235	.20½	.24½
14 in.—2 ft. from butt.	6 in.	70 to 79 ft.	.2125	.245	.24½	.30½
14 in.—2 ft. from butt.	5 in.	80 to 85 ft.	.275	.385	.....	.....
14 in.—2 ft. from butt.	5 in.	85 to 89 ft.	.315	.452	.....	.....

RAILWAY TIES

Prices f.o.b., per tie, for carload lots:		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Boston	Oak, untreated	$1.25	$1.80
	Pine, untreated	1.35	1.85
	Pine, creosoted	1.75	2.45
New York	Long-leaf sap pine, untreated	.80	1.00
	Mixed oak, untreated	.....	1.00
	White oak, untreated	.75	1.50
Birmingham	White oak, creosoted	no market	
	Southern pine, untreated *6x8x8'6"	.45*	.60*
	Southern pine, creosoted	1.00*	1.20
Chicago	White oak, untreated	1.15	1.40
	Oak, empty cell, creosoted	1.50	1.88
	Oak, zinc treated	1.40	1.70
	Southern pine, creosoted	1.35	1.78
Los Angeles	Fir, untreated	.50	.72
	Fir, creosoted	1.67	2.40
Philadelphia	Red oak, untreated	1.00	.....
	Red oak, creosoted	.....	2.10
St. Louis	White oak, untreated	1.03	1.35
	Red oak, untreated	1.00	1.30
	Red oak, creosoted	1.45	1.90
	Sap Pine or cypress, untreated	.90	1.25
San Francisco	Douglas fir, green, untreated	.45	.63
	Douglas fir, empty cell, creosoted	1.14	1.56
Montreal	Birch or maple, untreated	1.00	1.10
	Birch or maple, creosoted	1.25	1.55

CURRENT PRICES OF CONSTRUCTION MATERIALS

WATER, SEWER AND DRAIN PIPE

	C. I. PIPE	VITRIFIED SEWER PIPE (Per foot, delivered, standard (‡ f.o.b.))				CLAY DRAIN TILE (Per 1,000 ft., carload lots, f.o.b.)		CONCRETE SEWER PIPE (Per ft., delivered; ASTM C 14-24)		WROUGHT STEEL PIPE (Full standard weight, #)			
	Per net ton, f.o.b. 6 in. to 24 in.*	8 in., s.s.	12 in., s.s.	24 in., d.s.	36 in., d.s.	6 in.	8 in.	12 in.	24 in.	1 to 3 in., Butt Weld Black	Butt Weld Galv	3½ to 6 in., Lap Weld Black	Lap Weld Galv.
Atlanta	$43.00	$0.225	$0.405	$1.4625	$3.25	$80.00	$128.00	$0.50	$1.625	44%	37%	42%	24%
Baltimore	46.50	.25	.50	2.10	5.75	108.00	168.50	.75	2.00				
Birmingham	39.00	.25	.45	1.625	4.66	85.00	200.00	.45	1.60	48.939%	37.918%	50.162%	39.143%
Boston	46.50	.182	.351	1.62	5.0225	102.60	153.00	.378	2.15				
Chicago	47.50	.285	.54	1.98	5.60	85.00	120.00	.675	2.25	56%	45%	55%	46%
Cincinnati	46.00	.293	.3915	1.665	5.125	69.00	108.00	.40	1.40	53.04%	42.02%	54.265%	43.143%
Cleveland	47.50	.14	.27	1.17	3.9975	42.50	88.50	.536	2.102	58.4%	48.4%	60.6%	49.6%
Dallas	51.00	.25	.45	1.80	.....	160.00	250.00	.41	1.41	64%	55%	64%	56%
Denver	59.00	.23‡	.415‡	1.73‡	.....	.....	.....	.....	.....	56%	45%	43%[k]	57%[k]
Detroit	47.50	.245	.4725	2.025	5.74	82.00	136.00	.35	1.20	48.6%	38.2%	47.3%	37.6%
Kansas City	49.00	.32	.57	2.27	4.90	120.00	240.00	.40	1.50	49%	38%	50%	39%
Los Angeles	47.50	.2825‡	.508‡	2.03‡	5.535‡	115.50	192.50	1.00	2.00	53.57%	43%	53%	42.51%
Minneapolis	49.50	.255	.459	1.836	4.67	.....	.....	.50	1.34	.....	.....	.....	.....
Montreal	50.00	.80	1.50	6.00	.....	45.00	75.00	.45	.....	.....	.....	.....	.....
New Orleans	45.00	.32	.51	1.65	.....	67.00	.....	.45	2.00	.....	.....	.....	.....
New York	46.00	.26	.51	2.25	6.75	.....	.....	.55	2.00	51.88%[a]	40.86%[a]	53.10%[a]	42.08%[a]
Philadelphia	43.00	.336	.648	2.835	8.68	175.00	210.00	.54	1.80	52.37%[a]	41.35%[a]	53.39%[a]	42.52%[a]
Pittsburgh	49.00	.175‡	.3375‡	1.44‡	4.81‡	69.00	108.00	.75c	1.75	64%	55%	65%	56%
St. Louis	46.00	.255	.459	1.836	3.96	85.00	170.00	.80	2.00	51.266%	40.245%	52.49%	41.47%
San Francisco	47.00	.265	.477	1.908	5.22	103.50	172.50	.45	2.20	52.4%	63.4%	51.1%	64.6%
Seattle	48.50	.35†	.63†	2.52†	6.30†	96.00	200.00†	.50†	1.80	60%	50%	65%	50%

*b. & s. class B and heavier, C/L lots, 200 tons and over. Burlington, N. J. (base) $43.00. Gas pipe and class A, $3 per ton additional, 4-in., $3 per ton additional. 30 in. and larger usually $2 per ton less. ‡Price at factory. †Less 30% in C/L Lots.

#Discounts from standard list for delivery from warehouse, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c; ⅜ in. 11½c.; ½ in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92.

[a]2½ to 3 in. [k]Resale price to consumer, car load lots shipped from mill.

c Concrete Culvert pipe reinforced.

LUMBER AND TIMBER—PER M FT. B.M., CARLOAD LOTS F.O.B.

		SHORT LEAF YELLOW PINE AND DOUGLAS FIR (All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. All Fir planks No. 2 common; Fir timber is No. 1 common. Lengths up to 20 ft.)									LONG LEAF Y. P. Merchantable grade up to 20 ft.	
		1x6,[s]	1x8,[s]	2x4,[s]	2x6,[s]	2x8,[s]	2x10,[s]	3x12,[r]	6x12,[r]	12x12,[r]	2x12,[r]	12x12,[r]
Atlanta	Southern Pine	$15.00	$15.00	$17.00	$17.00	$17.00	$19.00	$25.00	.....	.....	$38.50	$40.00
Baltimore	Southern Pine	20.50	24.00	29.50	28.50	29.00	30.50	37.50			54.00	55.00
	Douglas Fir	29.50	29.00	31.00	29.00	30.00	30.50	32.00	$33.00	$34.00		
Birmingham	Long Leaf	18.00	18.25	18.25	16.25	17.25	17.25	39.00			34.00	36.80
	Southern Pine	18.00	18.25	17.00	15.00	16.00	16.00	26.00	26.00	25.00	.....	.....
Boston	Southern Pine	27.00	27.00	32.00†	33.00†	47.00†	55.00†	70.00†	.....	.....	70.00	70.00
	Douglas Fir	27.00	27.00	30.00	33.00	35.00	35.00	40.00	41.00	41.00	.....	.....
Chicago	Southern Pine	27.00	28.00	33.50	30.00	31.00	32.50	45.00	.....	.....	53.00	57.00
	Douglas Fir	28.50	29.50	31.75	30.50	30.50	28.50	40.75	41.75	41.75	.....	.....
Cincinnati	Southern Pine	24.00	25.00	26.00	25.00	25.50	26.50	40.00	.....	.....	31.50	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	43.50	46.25	46.25	.....	.....
Cleveland	Southern Pine	28.00	30.00	36.00	30.00	34.00	36.00	47.00	45.00	.....	53.00	62.00[g]
Dallas	Southern Pine	d31.50	32.40	35.55	32.50	35.50	35.50	55.00	.....	.....	51.90	64.35
Denver	Douglas Fir	41.00	41.00*[n]	42.00*	42.00*	42.00*	46.00*	52.00*	56.00*	61.50	.....	.....
Detroit	Southern Pine	24.00	24.00	25.00	24.50	24.50	25.50	35.00	.....	.....	29.00	41.50
	Douglas Fir	.....	.....	.....	.....	.....	.....	41.50	41.50	41.50	.....	.....
Kansas City	Southern Pine	23.50	24.00	23.50	23.00	23.50	24.50	34.00	.....	.....	53.00	60.00
	Douglas Fir	27.50	28.50	29.00	27.50	27.50	30.00	33.00	35.00	35.00	.....	.....
Los Angeles	Douglas Fir	30.00[g]	30.00[g]	30.00[g]	30.00[g]	30.00[g]	30.00[g]	35.00[g]	39.00[g]	34.00[g]	.....	.....
Minneapolis[c]	Western Pine	45.00*	51.50*	50.00*	41.00*	41.00*	42.00*	59.50*[x]	.....	.....	58.00*[x]	.....
	Douglas Fir	39.00*	42.00*	43.50*	41.00*	41.00*	42.00*	59.50*	59.50*	59.50*	.....	.....
Montreal	Spruce	28.00	29.00	25.00	27.00	30.50	33.00	36.00	.....	.....	.....	.....
	Douglas Fir	47.50	53.00	42.50	44.00	44.00	45.75	51.00	51.00	51.00	43.00	.....
New Orleans	Southern Pine	23.90	25.90	28.50	25.75	26.75	26.00	39.00	.....	.....	45.00	55.00
	Douglas Fir	28.95	31.50	33.50	29.35	32.90	33.95	37.95	.....	.....	.....	.....
New York	Southern Pine	33.00*	34.00*	33.00*	34.00*	34.00*	36.00*	45.00*	.....	.....	70.00*	70.00*
	Douglas Fir	.....	.....	38.00*	37.00*	38.00*	38.00*	38.00*	43.00*	43.00*	.....	.....
Philadelphia	Southern Pine	30.00	31.00	32.00	32.00	33.00	34.00	36.00	.....	.....	36.00	42.00
	Douglas Fir	45.00	45.00	45.00	45.00	45.00	45.00	45.00	42.00	42.00	.....	.....
Pittsburgh	Southern Pine	30.50	31.90	37.65	33.75	36.52	37.50	47.75	.....	.....	57.50	57.50
	Douglas Fir	38.52	39.70	39.70	38.55	39.10	39.38	53.25	53.25	53.25	.....	.....
St. Louis	Southern Pine	27.00*x	28.00*x	28.00*x	26.50*x	27.50*x	29.00*x	47.00*x	.....	.....	.....	.....
	Douglas Fir	.....	.....	.....	.....	.....	.....	.....	54.00*x	54.00*x	72.00	70.00
San Francisco	Douglas Fir	20.00[f]	20.00[f]	21.50[f]	21.50[f]	22.00[f]	22.50[f]	24.50	25.00[f]	25.00[f]	.....	.....
Seattle	Douglas Fir	14.00	15.00	15.00	14.00	14.00	14.00	20.00	19.00	19.00	.....	.....

*Delivered. †Spruce. ‡Long-leafed Y. P. §Norway Pine. [s]Northern Pine. [n]Native. [t]At ship's tackle. [g]Yard prices. [d]10% Disc. taken off. x5M ft. or less [s]S4S [r]Rgh. [c]Contractors in Minneapolis and St. Paul get 15% disc. from list.

CURRENT BUILDING AND CONSTRUCTION WAGE RATES PER HOUR

	Bricklayers	Carpenters	Structural Iron Workers	Hoisting Engineers	Plasterers	Common Labor Building	Common Labor Heavy Const.
Atlanta	$0.70/1.125	$0.40/.90	$0.60/1.25	$0.75/1.50	$0.60/1.00	$0.30/.40	$0.30/.40
Baltimore	1.25	1.10	1.37½	1.25	1.25	.45	.45
Birmingham	1.00	.60/1.00	1.00	1.125	1.00	.30/.40†	.30/.40†
Boston	1.20	.70/1.17½	1.20	.90/1.37½	1.37½	.50/.70	.50/.70
Cincinnati	.80/1.375	.65/1.20	1.25	1.00/1.25	.90/1.375	.45	.45
Chicago	1.50	1.31¼	1.35	1.31¼	1.50	.82½	.82½
Cleveland	1.375	1.12½	1.25	1.25	1.375	.72	.72
Dallas	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.25/.40	.25/.40
Denver	1.10	1.10	1.10	.....	.....	.50	.50
Detroit	1.25	1.00	1.25	.75/.95	1.25	.55/.60	.55/.75
Kansas City	1.32½	1.12½	1.125	1.12½	1.32½	.70	.45/.50
Los Angeles	1.10	1.10	1.25	1.25	1.25	.50	.60
Minneapolis	1.00	.70/.85	1.00	.85	1.00	.40	.45/.50
New Orleans	1.00	.75	1.00	1.00	1.25	.30/.40	.30/.40
New York	1.50	1.40	1.65	1.50/1.65	1.50	.82½	.50/.80
Philadelphia	.35/1.50	.65/1.10	.70/1.375	.90/1.00	1.10/1.37	.35/50	.40/.50
Pittsburgh	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.50/1.00	.35/.50	.35/.50
St. Louis	1.50	1.25	1.47	1.35/1.47	1.50	.78¾	.35/.78
San Francisco	1.50*	1.10	1.37½	1.12½	1.25*	.62½	.60
Seattle	1.00	1.00	1.25	1.25	1.25	.60	.60
Montreal	1.00	1.00	1.25	1.25	1.25	.60	.60

Skilled Avg: (Bricklayers, Carpenters, Ironworkers) $1.099 Common Avg. $0.5275 *6-hr. Day. † PWA.

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